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ADDRESS OF THE PRESIDENT

WHITHER ANON*

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THOSE OF US who were present will not soon forget the meeting of the Southern Surgical Association in 1941, which was held only a few days after that tragic Sunday of December 7. Since that time we have all concentrated our attentions and efforts toward eliminating Nazism, Fascism, and "Rising Sunism." Now, however, with the possibility that the war may end none too quickly, we, as a medical profession, are confronted by new problems and must face new horizons.

Unfortunately, during the period of global conflict medical education has suffered materially. In order to furnish more physicians for the Armed Forces, medical schools cooperated with the Army, Navy, and Public Health Services in accelerating the medical school programs. Although every attempt was made to give courses equal to those given in peace time, generally this has not been accomplished for two reasons: first, many students became "stale" or fatigued because of the intensive training which they received; and, second, and probably more important, many of the teaching personnel volunteered for active duty which left only a skeleton staff to carry on the instruction. Although undergraduate teaching has suffered considerably, this is of relatively little consequence when compared with the almost complete interruption in graduate training. Unfortunately, the high standards which had been set and attained by the various certifying boards and approving bodies

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had to be disregarded during the war period, because with few exceptions medical graduates enter active military service immediately after a nine months' internship and only a few are able to obtain a nine months' or possibly an eighteen months' residency. Because of this, the specialty training program which had been so carefully developed and which was operating so efficiently before war was declared collapsed completely, and for the war period there will be a very small number of specialists trained, resulting in a great decrease in the total number of especially trained physicians. In the post-war period, as quickly as demobilization is accomplished, there will be a need for a large number of places for advanced training, because not only will those physicians who in normal times would have obtained specialty training want it, but also many others will desire residencies. Many of the latter group will be stimulated to request specialty training because of the experience which they have had with specialty group practice in the service. This is evidenced by the results of the pilot survey made by the Committee on Post-War Medical Service which showed that slightly over 80 per cent of the men in service desired additional training and that over half (58.2 per cent) desired a prolonged training.¹ As the number of residencies and fellowships which were available before the outbreak of the war was insufficient to satisfy the demands at that time, it is obvious that the number of places available for specialty training will be woefully inadequate in the post-war period. It is estimated that approximately 15,000 men will desire some type of surgical training and that 10,000 will want prolonged training in surgery,¹ and since in 1943 there were only 2,584 approved surgical residencies,² it is, thus, evident that additional facilities must be made available for the training of these men. Davison³ has suggested that the number of residencies might be doubled in the post-war period in order to accommodate an increased number of trainees. Although this probably should be done in many institutions, it is not particularly desirable because it would decrease the value of a residency, particularly in the surgical specialties in which a relatively greater number of patients are required for resident training than in the medical specialties. Whereas a dozen or more graduate students can examine the same medical patient with approximately equal benefit to all, only one surgeon can operate upon a patient. Additional places for graduate training can be obtained by using facilities which have not been utilized before. There are in the United States a large number of institutions which have not been approved for residencies, but which can, should, and must be utilized in the post-war period. It is obvious that the obtaining of additional beds alone is not all that is necessary for increasing the number of suitable residencies. Of even more importance is the supervision of work done by the trainee. Unfortunately, in the past there has been supervision only in the well-controlled institutions, and generally those in which teaching has been done. There is no reason, however, why in the future outlying institutions cannot be placed under the jurisdiction of a teaching institution and be utilized for

resident training. Such plans are in operation now in California under the auspices of the University of California Medical School, in Michigan under the auspices of the University of Michigan Medical School, and are contemplated in Louisiana under the auspices of Tulane University. It is proposed that supervision of the trainees in the outlying institutions be done either by a full-time staff member who is supplied by and who is directly responsible to the University or by a responsible member of the staff who is appointed as the University representative in that institution. These men would be responsible for and would supervise the work of the residents and would report from time to time to the University. The residents should spend a certain period (probably six months) of their training in the University proper at which time they would receive training in the fundamental sciences. In this way a large number of additional residencies could be made available in all branches of medicine, and yet a high standard of training could be maintained. It is possible that a resident after having served several years in a university hospital might be appointed as chief resident in one of the smaller hospitals. This would permit him to have considerable experience and responsibility and at the same time he could exert an excellent influence on the practice of medicine in that hospital, because he would be able to bring to the institution the methods, ideas, and ideals of the teaching hospital. In order for this plan to be successful, it would be necessary to have the hearty cooperation of the staffs of the hospitals concerned, and it is possible that there might be some antagonism to the plan. On the other hand, if the staff members of these hospitals would appreciate the fact that in this way, and in this way alone, would it be possible for them to attract well-trained residents, they would realize the value of the plan to the hospital, their patients, and themselves.

It has been emphasized by Dean Kostmayer, of Tulane University, that in the future some provision should be made whereby it will be virtually obligatory for every physician to take postgraduate courses from time to time. There is no science which is less static than medicine, and it is untenable for a physician to assume that because he has received his diploma and license to practice medicine he need no longer study and keep abreast of the times. Fortunately, the need for obtaining additional graduate training from time to time is appreciated by most physicians, but, unfortunately for the public, those who need it most realize it the least and seldom, if ever, have any further training. It would be extremely desirable, however, if it were necessary to renew at periodic intervals the license to practice and if such a renewal were possible only if the physician could show evidence of having received additional training.

For the past decade and a half we have all heard a great deal about socialized medicine, and most of the medical profession have immediately condemned this form of practice as being detrimental to good practice and as one which would destroy medicine in general. I fear that many times the arguments advanced by the profession against this form of practice have been

for personal reasons, and although self-preservation is desirable, it is less likely to be accepted as justification for the continuation of private medical practice than a less selfish one. Unfortunately, when one speaks of socialized medicine, it is usually not realized that even at the present time medicine is to a certain extent socialized. Certainly the care of the indigent patient in federal, state, or city charitable institutions is socialized medicine. The activities of the Public Health Service in its control of the communicable diseases, the medicine in the Armed Services, and that practiced in institutions for tuberculosis and mental diseases are forms of socialized medicine. Even in private practice, the frequently used plan of a sliding scale of fees is a type of socialized medicine. A total expenditure for medical care in a normal year is \$3,656,000,000, of which \$509,000,000 (16 per cent) is paid directly by the government.⁴ At the outset, therefore, we all must admit that we already have socialized medicine and have practiced it for some time.

Before one can consider intelligently the necessities, advantages, and disadvantages of proposed federal legislation to supply complete medical care to all persons, there are several questions which should be answered: Is there need for any change in medical practice in America to-day? Is medical practice adequate to meet the present requirements? Are the proponents of federal medicine justified in their claims that a change must be made? The statement has been made frequently in the past that in the United States to-day the best medicine of the world is practiced. This is undoubtedly true for indigents who can be admitted to charity institutions, particularly if these hospitals are staffed by the faculty of a medical school. This is also true for the wealthy who are able to obtain and to pay for the required medical care. However, is it possible for the masses of people who comprise the so-called white collar class to obtain adequate medical attention? According to Simons and Sinar⁵: "The first point to determine is whether there is, in the United States, any large section of the population with an income too small to meet the cost of necessary medical care. This question must never be raised among those familiar with the facts. That it is continuously raised, and the existence of such a class denied by representatives of the medical profession, is one of the principal counts and indictments of economic and social ignorance brought against those professions. There is not a single competent student of the subject who does not agree that several million of the population in this country receive incomes insufficient to purchase the fundamental necessities of life. This conclusion is indorsed by employers' organizations and trade unions, by the United States Bureau of Labor, charity workers, economists, statisticians, and sociologists of every type and attitude. It is one of the very few undisputed facts in the realm of economics. Yet, its explicit or implied denial is constantly found in writings admitted to medical and general journals." According to Buehler,⁶ in 1928, at the height of prosperity, 15 per cent of families had an annual income of less than \$1200.00; 34.8 per cent had an income from \$1200.00 to \$2000.00; 24.6 per cent an income of \$2,000.00 to

\$3,000.00; 15.7 per cent an income from \$3,000.00 to \$5,000.00; 7 per cent an income from \$5,000.00 to \$10,000.00; and only 2.9 per cent had an income of \$10,000.00 or more. Seventy-four and eight-tenths, or approximately three-fourths of all families, had an annual income of \$3,000.00 or less and half (49.8 per cent) had incomes of \$2,000.00 or less even in boom times. The average annual costs of medical care for these same groups were as follows: under \$1200.00, \$49.00; \$1200.00 to \$2000.00, \$67.00; \$2,000.00 to \$3,000.00, \$95.00; \$3,000.00 to \$5,000.00, \$138.00; \$5,000.00 to \$10,000.00, \$249.00; and \$10,000.00 or more, \$503.00. Reed⁴ showed in a study made in 1928 of the incomes of 29,000,000 families that 14 per cent of the families with an average of four and one-half persons per family had incomes of less than \$1,000.00; 30.3 per cent had an income of \$1400.00 or less; 68.1 per cent had an income of \$2500.00 or less, whereas 90.8 per cent had an income of \$5,000.00 or less. There were only 9.2 per cent with family incomes of \$5,000.00, and 2.67 per cent with incomes over \$10,000.00. Over half of the families (55.3 per cent) had an income of \$2,000.00 or less. Carey,⁷ from 1935-1936 statistics, found that there were over twelve million families with annual incomes of \$1,000.00 or less and over two million with incomes of \$500.00 or less. From 1942 statistics, at which time there was considerable employment and high wages were paid, he found that there were thirteen million families with incomes of \$1500.00 or less. Carey⁷ maintains, and justly so, that the 1935-1936 statistics probably more closely approach the post-war incomes than those of 1942. It is, thus, apparent that there are many families even now, and in the post-war period there will be probably many more, who can afford to pay only a modest amount for medical care. On the other hand, it must be emphasized that a much larger quantity of money is spent on luxuries than for medical care. According to Cabot⁸ more than four times the amount spent on medical care is spent for "passenger automobiles, noncommercial use of gasoline, tobacco, candy, cosmetics, soft drinks, toys, jewelry, and amusements." According to Reed⁴: "The amount spent each year for tobacco alone is not quite the total gross income of all physicians; the amount spent on candy is more than twice that expended on civilian hospitals; the amount spent for cosmetics is about twice the expenditures for nurses."

Unfortunately, with the advance of medical sciences and with the increase in specialization which has become necessary since medicine has gotten so complicated it has become impossible for one to familiarize himself with all branches. Diagnosis has become more complicated and more difficult, and a more prolonged and elaborate training of the physician is essential. Whereas our predecessors made a diagnosis by looking at the tongue, counting the pulse, and recording the temperature, and they were correct in a large number of instances, at the present time such a cursory investigation could not and would not be accepted. I am perfectly willing to admit that the general practitioner of fifty years ago could tell more on a single visit

by the use of his own special senses and without elaborate diagnostic instruments than the specialist of to-day, and it is probable that the modern physician does not develop the faculty for depending upon his own resources and relies upon more complicated laboratory procedures. On the other hand, was the practitioner of fifty years ago able to make a diagnosis of bronchiogenic carcinoma, adenoma of the parathyroid, or osteoid osteoma, to say nothing about the many other diseases which were unknown at that time and which can be diagnosed only by laboratory examinations, many of which are complicated and prolonged? In order to perform these complicated laboratory examinations it is necessary to have expensive, elaborate equipment in addition to highly trained physicians and technicians. The increased cost of medical care at the present time is attributable to several factors: (1) the greater expenditure necessary to obtain a medical training; (2) the need for frequent consultations with especially trained physicians because of the great advances in medicine; and (3) the necessity of complicated laboratory examinations. It is my belief that the last factor is probably the most important of all in increasing medical costs, because there is no physician who would not treat a patient no matter how poor he may be and who would not give his services either without cost or for that which he can pay. On the other hand, decrease in the fees for complicated laboratory examinations has not been possible, and this, probably more than anything else, has been responsible for not obtaining the examinations needed in many cases. I would not care to leave the impression that complicated laboratory examinations are undesirable. In fact, without some, many of the modern more common diagnoses would not be possible. On the other hand, because of the cost of the complicated laboratory work, a physician is tempted to refrain from using them in order to save the patient with a moderate income the additional expense. Because of this, his diagnostic acumen is decreased and without a correct diagnosis, therapeutics is likely to be symptomatic, unscientific, and ineffectual. In this way, and in this way alone, is the medicine of to-day not the type it should be for a large number of persons who cannot afford such expensive examinations. That the increase in medical care is not because the physician charges too much is evidenced by the estimated income of physicians as determined in 1929, which was the year of high prosperity.⁹ Of all private practitioners, one-half had annual net incomes of \$4,000.00 or less. The other half of all physicians had an average net income of \$5,700.00. This includes all physicians, general practitioners, partial and complete specialists. It is estimated that in 1929, 33 per cent of the physicians and 22 per cent of the dentists had inadequate incomes, taking \$2500.00 as the net income which would be adequate. In 1932, at which time there was a definite decline in the income of physicians (an estimated 40 per cent between 1929 and 1932), the average net income of all physicians in private practice was \$3,450.00.⁹

The amount of money spent for medical care annually is about three and two-thirds billions of dollars, which represents approximately 4 per cent

of the income of the entire population. Approximately 14 per cent of this amount is provided by tax funds (federal, state, and local); philanthropies provide 5 per cent; industry, 2 per cent; the remaining 79 per cent is paid by private individuals.⁹ The cost of medical care, including hospitalization, medicine, and physicians' fees, is considerable, but it is only a portion of the cost of sickness. Generally, the income of the wage earner decreases or stops entirely during an illness, and this is even more of a financial burden than the cost of medical treatment. There are in each year about eight recognized illnesses among each ten persons, seven for each ten males and nine for each ten females.⁹ Because of this, it becomes increasingly more important for medical practice to emphasize prophylaxis as well as treatment because if the individual can be kept well and if sickness can be prevented, the cost will be materially less because his earning capacity will not be interfered with. It has been estimated by Falk⁹ that about 500 cases of disabling illness will occur in an ordinary year among each 1,000 persons of the population. Among those occupied in gainful occupations between the ages of fifteen and sixty-five, about 28 per cent will have one or more disabling illnesses during a year, 15 per cent will be disabled for eight days or less, 10.5 per cent will be disabled for nine to forty-five days, and from 2 to 2.5 per cent from forty-five to three hundred and sixty-five days.

These figures indicate that the economics of medicine as practiced today can be and are hardships to a large number of people and that some change in medical practice is necessary. The problem of meeting the costs of medical care would not be so difficult if one were able to anticipate an illness at any particular time and budget for it. Fortunately for those who remain well, sickness does not occur with regularity. One may go several or more years with no illness, but finally have several illnesses within a short time. According to Falk,⁹ the annual incidence of illness in 1,000,000 persons is as follows: 470,000 will suffer no recognized illness, 320,000 will be sick only once, 140,000 will be sick twice, 50,000 will be sick three times, and 20,000 will be sick four times or more. It is during the years that illness occurs or multiple illnesses occur that the burden is thrown upon those who have modest incomes.

The present difficulty is not primarily the fault of the medical profession because, as shown by the average income of physicians, the high cost of medical care is not due to excessive earnings by the profession. Although we of the profession are not directly responsible for the hardship resulting from increased medical costs, we should not deny that a need for a constructive plan exists and should actively support or institute such a plan. The proponents of federal medicine have justification in their arguments that a change in medical practice is necessary. It is my belief that organized medicine has been derelict in not assuming its proper leadership by not fostering a national plan for medical care. We should accept the admonition of the disciple Luke: "Physician, heal thyself" (Luke 4:23). No longer should we as a profession deny that a change is necessary and to continue

arguing that any plan which might be introduced by the Federal Government is undesirable because it would destroy medical practice will continue to bring discredit upon the profession because of apparently selfish motives. On the other hand, unless the medical profession offers a plan which is constructive and which will correct the now existing deficiencies, there is not only the possibility but also the likelihood that some type of Federal Medicine will be adopted. Therefore, we physicians should, in the words of Milton: "Awake, arise, or be forever fallen" (*Paradise Lost*). Since socialization of medicine already exists and since it is evident that the proponents of Federal medicine have justification in their arguments that a change in medical practice is necessary, the question naturally arises whether there should be federalization of medicine, as proposed in the Murray-Wagner-Dingell Bill or not. Because of the inability of a large class of individuals to pay for adequate medical care, it is obvious that some plan must be instituted which will provide adequate care for all individuals. Can this be accomplished without federalization of medicine with its bureaucracies, wastefulness, and inefficiencies? Is it possible to permit budgeting for illness, because illness cannot ordinarily be budgeted in the way that other expenditures can and can this be done effectively or efficiently? The budgeting for illness could be accomplished by means of some form of prepayment plan for medical care. At the present time, there are in force in the United States a number of such plans, but which unfortunately are limited to certain states. The value of budgeting for illness is exemplified by the benefits which have been derived from the Blue Cross Plan which permits prepayment for hospitalization. Before the introduction of this plan, which at the present time has approximately 16,000,000 subscribers, the high cost of hospitalization was prohibitive to a great many persons with moderate incomes. Now with the prepayment plan for hospitalization this part of medical care no longer represents a hardship. Although the Blue Cross Plan does not apply to medical care aside from hospitalization, it has been valuable in relieving medical costs, because by being relieved of the burden of paying the hospital, one is better able to pay his physician. In this way the physician has also profited. It is probable that the most practical plan would be one which would not cover all illnesses because certainly the cost of occasional minor illness is no great hardship even to the individual with a small income, but the cost of a major illness represents a real difficulty. This plan could be offered much more cheaply than one that is all inclusive just as an automobile collision policy with a fifty dollar deductible clause is much cheaper than a complete coverage policy. In a survey made by the Opinion Research Corporation¹⁰ it was found that of the 63 per cent of people who thought that something could be done about making it easier to pay for illness, only 5 per cent wanted it to apply to the ordinary doctor bills. Although there are many plans operating in a number of states in the United States and in several foreign countries, there is no national plan providing medical care in the United States. The state plans apparently have been very suc-

cessful. It is difficult to understand why such an obvious need should not be sponsored on a nationwide basis. There are many prepayment plans for medical care in operation throughout the United States but at the present time, according to McCann,¹¹ there are no state programs that sell complete medical care.

As long ago as 1934, the American College of Surgeons recognized the need for some program to decrease the financial burden of illnesses in persons with moderate incomes. On June 10, of that year, the Board of Regents of the College of Surgeons accepted the report of their Medical Service Board¹² which had studied the problem extensively. The following are excerpts from this report: "The American College of Surgeons affirms its interest and its desire to cooperate with other agencies looking toward the provision of more adequate medical service to the whole community. The College believes that it is its duty to the medical profession to assume leadership in this movement and to take control of all measures directed to this end. The College recognizes for immediate study four groups of the population for whom more adequate medical service should be made available as follows: (a) the indigents; (b) the uneducated and credulous members of the community; (c) those who because of limited resources are unable, unaided, to meet the cost of serious illness and hospitalization; and (d) those living in remote districts where adequate medical care is not obtainable. The American College of Surgeons recognizes the periodic prepayment plan providing for the cost of medical care of illness and injury of individuals and of families of moderate means offers a reasonable expectation of providing them with more effective methods of securing adequate medical service." Unfortunately, these recommendations were not only not accepted by the profession generally, but were actually opposed. Had the suggestions made by this body been put into operation on a nationwide basis, I believe that the problem of inadequate medical care would have been solved by this time. The National Physicians Committee for the Extension of Medical Service has done and is doing a great deal in emphasizing the need for plans to make payment for illness easier, as evidenced by their statement of policy: "Steps must be taken to make available to the indigent and low income groups the most effective medicine, medical practice and hospitalization that can be provided and generally provide the widest possible distribution of the most effective methods and equipment in medicine and surgery."¹⁰ Unquestionably their ideas are sound and their program should be supported because it is the one body which has attempted to formulate a constructive plan.

In the interest of the patient, the organization and administration of the plans for periodic prepayment of medical and hospital costs must be under the control of the medical profession. The medical profession must act in conjunction with the hospitals and such other allied services as may be involved in the project, together with groups of representative citizens and of industry who are interested in the successful operation of the plan.

It would be extremely undesirable for the program to be controlled by the government, because the character of the medicine practiced would be definitely inferior, much more expensive, and less efficient.

The principle of free choice of physician and hospital by the patient must be assured to the end that the responsibility of the individual physician to the individual patient will always be maintained. The plans which have been introduced throughout the United States have been almost entirely voluntary, and it is the consensus that voluntary prepayment as practiced by the Blue Cross Hospital Program is preferable. Rhode Island is the only state in which there is compulsory insurance.¹³ However, this has been in operation only a year, having completed its first year on April 1, 1944, and the program is for cash disability benefits and does not include medical service or payment for such service.

In this cursory outline of the problems facing our profession today, I sincerely hope that I have been able to convince you of the necessity for providing more places for specialty training in the immediate post-war period and even more important, the exigency of formulating and putting into operation a nationwide prepayment plan for medical care. We must no longer maintain the ostrich-like attitude that there is no need for a change in medical practice and not only not oppose constructive programs but actually formulate and promote a plan which, by permitting periodic prepayment, will remove the curse from illness for the masses of people whose income at the present time does not allow adequate medical care. The promulgation of a constructive plan by the profession on a nationwide basis will reasonably assure the defeat of those measures which provide for federal medicine with its bureaucracies, inefficiencies, and inadequacies.

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TREATMENT OF CARCINOMA OF THE COLON*

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OPERATIVE TREATMENT of lesions of the colon has presented the surgeon with many difficult problems in technic since it concerns an organ whose continuation of function is necessary to nutrition and life, an organ filled with pathogenic bacteria, and one in which anatomic peculiarities make for operative difficulties. Many operations have been devised and popularized to meet and overcome these difficulties. The historical aspect of the bold and ingenious methods of treatment have been presented so well by many writers on the subject that we will only acknowledge our debt to them and refrain from further mention. There is not as yet, and probably never can be, a standardized method of caring for such lesions since they vary greatly in size and metastatic spread, and develop in patients who also may have a myriad of complications and associated diseases. Many surgeons have reported the results of their treatment of lesions in this organ, but the total number of patients treated under varying conditions of disease and type of operation is still too small to be statistically convincing. Progress will come with the summation of the experience of all working in this field. In order to contribute to the final total we are reporting here observations on the treatment of 173 patients with carcinoma of the colon proximal to the rectosigmoid junction, managed in the University Hospital between January 1, 1940, and September 1, 1944. Our purpose in reviewing this series was to evaluate our results in the treatment of carcinoma of the colon at the time when we were attempting to utilize primary end-to-end anastomosis, insofar as this method seemed safe and feasible. This communication will not concern itself with end-results, but will be confined to a discussion of the immediate results of operative treatment of the patients entering the University Hospital primarily for relief of their diseases. The end-results will be presented later.

These patients include all cases treated by the permanent and resident staff. The operations were performed by fourteen different surgeons, most of them, however, were performed by the senior surgeons.

TABLE I
SITE OF CARCINOMA OF COLON EXCLUSIVE OF LESIONS OF RECTOSIGMOID
TREATED FROM JANUARY, 1940 TO SEPTEMBER, 1944

Right colon, cecum, ascending colon and hepatic flexure...	60
Transverse colon.....	21
Splenic flexure.....	9
Descending colon.....	13
Sigmoid colon.....	70
Total cases.....	173

* Read before the Fifty-sixth Annual Session, Southern Surgical Association, December 5-7, 1944, Hot Springs, Va.

In Table I, is shown the site of origin of the cancer in relation to the part of the colon involved by the primary lesion. These figures only confirm the observations of many others and present no subject for comment.

TABLE II
TREATMENT OF CARCINOMA OF THE RIGHT COLON AND HEPATIC FLEXURE

1. Palliative (nonresectable lesions):	Number	Deaths	Mortality
Ileotransverse colostomies.....		3	23.0%
Open anastomosis.....	4		
Closed anastomosis.....	9		
Total.....	13	3	23.0%
2. Resectable lesions:			
One-stage right colectomies.....	6	0	0
Two-stage right colectomies:			
(1) Ileotransverse colostomy:			
Open anastomosis.....	22		
Closed anastomosis.....	18		
(2) Right colectomy.....	40	1	2.5%
Obstructive resection.....	1	0	0
Total resectable lesions, right colon.....	47	1	2.15%
Total.....	60	4	6.6%

In Table II, is shown an analysis of patients presenting themselves with carcinomas of the right colon. They are divided into two groups: first, those in which the lesion was not resectable or in whom resection was not worth while because of extensive metastases; and, second, those in whom the lesion was resectable. In the latter group the primary lesion was resectable but it also includes many patients with metastases or distant spread in whom resection was clearly only a palliative measure. Resection was always effected if it was thought that cure might result and also when it was felt that it would add to the comfort and longevity of the patient even though cure would not be possible because of the presence of metastases. Since studies on lymphatic spread of carcinoma (Coller, Kay and MacIntyre¹) show that lesions in the cecum, ascending colon, hepatic flexure and in the right transverse colon may spread in a retrograde fashion to involve lymph nodes in the ileocecal angle, we carry out excision of the right colon including the lower ileum to the midtransverse colon in lesions lying between these points. This insures a removal of the maximal area of nodal involvement.

Sixty patients with cancers of the right colon were treated. In 13 of them palliative side-tracking operations, ileotransverse colostomies were carried out. Resection of the primary lesion was impossible or was unwise because of massive metastases to the liver in eight patients and widespread peritoneal involvement in five. Combinations of these spreads were present. Three of these patients died while in the hospital, two were deeply jaundiced, with extensive liver metastases, one died on the seventh postoperative day and the other 21 days following the operation. A third patient with extensive liver and peritoneal metastases died of pneumonia seven days following opera-

CARCINOMA OF THE COLON

tion. There was no evidence of peritonitis in any of them but we can only assume that there was no disruption of the anastomosis since autopsy was not obtained. Ten others left the hospital in an average of 17 days following side-tracking of the primary lesion. All patients in this group were beyond the hopes of cure by any surgical attack.

In 47 patients the lesion was resected. In six patients it was carried out in one stage with closed method of anastomosis, without event. In 40 patients the lesion was resected by the two-stage procedure which we have felt is the safest one since the study of our results in such cases by Ransom in 1939.² In 22 patients the preliminary end-to-side ileotransverse colostomy was performed by the open method and in 18 by the "aseptic" method. None of these patients died following this preliminary operation. Right colectomy was carried out as a secondary operation following the preliminary anastomosis. One patient died following a second-stage right colectomy of a duodenal fistula on the 43rd postoperative day. The primary lesion was an extensive one involving the adjacent retroperitoneal structures and duodenum. Post-mortem examination showed a duodenal fistula with carcinomatous involvement of the retroperitoneal structures, the liver, peritoneum and duodenum, a lesion hopeless for surgical excision. One obstructive resection was carried out for a lesion in the hepatic flexure. The mortality for resection in this series is 2.15 per cent, in contrast to our mortality in 1939 as reported by Ransom as 20 per cent. As noted, the single operative death following right colectomy was in the instance of an incurable lesion. There were no deaths in patients in whom cure might be hoped for. The total hospital mortality for all patients with carcinoma of the right colon both hopeless and resectable was 6.6 per cent.

There are several different methods of surgical approach to the problem of right colectomy for carcinoma. Lahey, *et al.*³ advise exteriorization of the colon and ileum following resection with subsequent closure of the stomas. Whipple⁴ urges the importance of the routine use of the Miller-Abbott tube near the site of the anastomosis following a one-step resection. Mayo⁵ advocates the one-stage resection. All of these methods have importantly reduced the mortality in the hands of their advocates. We realize the importance of flexibility and individualization of surgical procedure but further personal experience has served only to satisfy us with the two-stage operation in most cases of cancer of the right colon, as described by Ransom in a study of carcinoma of the right colon. Small lesions may be resected in one stage by the experienced operator, with brilliant results. If the lesion is fixed, infected or extensive, requiring wide dissection with removal of the mesocolon and the abdominal wall, this emphasizes the value of the two-stage operation. There are two phases to the treatment; one, restoration of the continuity of the gastro-intestinal tract; and two, an extensive intraperitoneal dissection with associated widespread traumatic peritonitis. If anastomosis of small to large bowel is made at the same time as the extensive resection, the fate of the function of the anastomosis is dependent upon the anastomosis plus the asso-

ciated traumatic peritonitis. Intra-ileal decompression certainly is necessary and indicated under these circumstances. We feel that with a preliminary anastomosis carried out under a controlled technic, either the open or closed method, with quick restoration of the function of the bowel through the new channel, ileus and its concomitant symptoms are reduced to a minimum. We have rarely been obliged to decompress the small intestine following ileo-transverse colostomy. When this anastomosis functions, the right colectomy can be carried out with its associated traumatic peritonitis without marked interference with the function of the gastro-intestinal tract. Stage operations have drawbacks, since each stage carries the dangers of any operation, but our experience causes us to continue to adhere to this procedure in this instance for the reasons given. The use of the transverse incision and early mobilization of patients has cut down the hospitalization time with this two-stage procedure until the time element is no longer an argument against it. We have been impressed with the importance of the transverse incision and this approach is now routine in our clinic, in both right and left colectomy. It will be discussed later in this paper.

TABLE III
TREATMENT OF CARCINOMA OF THE TRANSVERSE COLON

	Number	Deaths	Mortality
1. Palliative:			
Celiotomy and peritoneal drainage.....	1	1	100%
Cecostomy with peritoneal drainage.....	1	1	100%
Total.....	2	2	100%
2. Resectable lesions:			
Primary end-to-end anastomosis.....	11		
Open anastomosis.....	2		
Closed anastomosis.....	9	1	11%
Obstructive resections with partial resection, stomach and jejunum.....	4	2	50%
Complementary cecostomies.....	8		
Preliminary cecostomy.....	1		
Two-stage right colectomies.....	4	0	0%
Open anastomosis.....	3		
Closed anastomosis.....	1	0	0%
	19	3	15.8%
Total.....	21	5	23.8%

Carcinoma of the transverse colon frequently involves adjacent organs, especially the stomach and jejunum and offers more difficult problems for surgical eradication. Table III, sums up the results in the treatment of 21 such lesions. Some lesions involving the right transverse colon were grouped with the lesions of the right colon as previously discussed. Two patients with an obstructing lesion of the transverse colon were admitted with perforation of the cecum and widespread peritonitis. They were treated by celiotomy with drainage and cecostomy, with death in both cases. Of the resectable lesions, ten were treated by excision and end-to-end anastomosis by open or

CARCINOMA OF THE COLON

closed methods. There was one death in this group following resection of the primary lesion, with a partial gastrectomy and resection of the involved jejunum. This patient died from shock on the second postoperative day. In four other patients extensive resections of the colon, stomach and jejunum were carried out for widespread carcinomatous involvement, with exteriorization of the ends of the colon. Two of these patients died, one on the tenth postoperative day of peritonitis, and a second on the first postoperative day of myocardial infarction. In four patients with a lesion in the midtransverse colon, two-stage operations were carried out in the right colon without mortality. The mortality following resection of lesions of the transverse colon was 15.8 per cent, and the total mortality, including two patients with general peritonitis from perforation, was 23.8 per cent. The deaths from resection were all in patients with wide spread lesions involving adjacent organs in whom extensive resections of stomach and jejunum were carried out and in whom the hope of cure was slight.

TABLE IV
TREATMENT OF CARCINOMA OF THE SPLENIC FLEXURE

End-to-end anastomosis:	Number	Deaths	Mortality
Closed.....	4	0	0%
Open.....	1	0	0%
Cecostomy:			
Preliminary.....	1		
Complementary.....	4		
Obstructive resections.....	4	1	25%
Total.....	9	1	11.11%

The splenic flexure offers great operative difficulties because of the intimate relation of the lesion with the stomach and spleen. As shown in Table IV, there were nine patients with lesions at this site. Five of them were treated by resection with end-to-end anastomosis, without mortality.

Four patients were treated by resection of the obstructive type, one of whom died. This patient had a large lesion involving the jejunum, with perforation and abscess formation. The splenic flexure and a portion of the jejunum were resected and the abscess cavity drained; a hopeless case in which gross carcinoma was present on the peritoneum and in the deep mesenteric nodes beyond the reach of removal; he died of operative shock on the first postoperative day. The mortality following resection of carcinoma in this segment of colon was 11.11 per cent. The one death was a patient with a hopelessly far advanced carcinoma.

In Table V, is shown the results of treatment of 13 patients with lesions of the descending colon; nine were treated by resection with primary anastomosis and four by resection of the obstructive type. There were no hospital deaths. In most of these patients the splenic flexure was removed and an anastomosis was made between the transverse and the lower portion of the descending colon or with the upper end of the sigmoid colon.

TABLE V

TREATMENT OF CARCINOMA OF THE DESCENDING COLON

End-to-end anastomosis:	Number	Deaths	Mortality
Closed.....	6	0	0%
Open.....	3	0	0%
Preliminary cecostomy or colostomy.....	4		
Complementary cecostomy.....	5		
Obstructive resections.....	4	0	0%
Total.....	13	0	0%

TABLE VI

TREATMENT OF CARCINOMA OF THE SIGMOID COLON

1. Palliative (nonresectable lesions):	Number	Deaths	Mortality
Celiotomy—only.....	1	0	0
Celiotomy with colostomy.....	11	1	9.9%
Cecostomy—peritonitis.....	1	1	100%
Total.....	13	2	15.4%
2. Resectable lesions:			
End-to-end anastomosis.....	51		
Closed.....	30	0	0
Open.....	21	1	4.7%
Obstructive resections.....	6	0	0
Total.....	70	3	4.2%
Preliminary cecostomy.....	12		
Preliminary colostomy.....	8		
Complementary cecostomy.....	31		
No decompression.....	6		

In Table VI, is shown an analysis of the patients presenting lesions of the sigmoid colon exclusive of lesions involving the rectum or the recto-sigmoid junction. There were 70 patients of whom 13 were nonresectable. In one of the 13 patients cecostomy was performed for symptomatic relief of obstruction, however, he succumbed to peritonitis already present as a result of perforation. Celiotomy alone was carried out in one patient with a frozen pelvis and extensive peritoneal and hepatic metastases. In the remaining 11 cases, celiotomy with colostomy was performed. Resection was impossible or deemed not worth while in seven of the 11 patients because of extensive hepatic metastases, and widespread peritoneal involvement; and in four patients, because of a fixed lesion in the pelvis in addition to extensive peritoneal metastases. Pulmonary embolism was the cause of one death following colostomy. In the treatment of these hopeless lesions, the mortality rate was 15.4 per cent.

In 57 patients of this group, the lesions were resected by the aseptic method in 30, by the open method in 21 and by obstructive methods in six. In 32 patients there was no gross evidence of any spread of the disease and cure can be hoped for. In 21 patients there was gross evidence of the presence of unremovable cancer and the resection could only be palliative in effect. Of these, 13 had hepatic metastases, six presented peritoneal spread and in

CARCINOMA OF THE COLON

two the lesion involved the bladder. The involved area of the bladder was resected but recurrence was considered probable. Multiple lesions of the bowel were encountered in six patients in whom segments of the ileum were resected and restoration effected by end-to-end anastomoses. In two patients two separate carcinomas of the colon were encountered, both being resected and continuity restored by the aseptic end-to-end method. It is of interest to note that in six patients with extensive local and peritoneal involvement, resection of the obstructing lesion was carried out and the anastomosis was made between bowel ends, the peritoneal surfaces of which were invaded by carcinoma, all united without event. In the 57 patients upon whom resection of a primary lesion was performed there was one death, a mortality of 1.8 per cent. This patient died of peritonitis due to the employment of an unwise technical method. A rubber tube was placed in the descending colon some inches above the site of anastomosis for purposes of decompression. The tube was pulled out by the patient with resultant fecal spread and peritonitis. A cecostomy would have been preferable and probably would have obviated the complication.

TABLE VII
SUMMARY OF THE MANAGEMENT OF CARCINOMA OF THE COLON AND MORTALITY

	Number	Per Cent
Lesions resected.....	145	83.8
Lesions not resectable:		
Palliative operation.....	28	16.2
Of lesions resected:		
(a) Other gross carcinoma—irremovable:		
(1) Liver metastases.....	20	
(2) Peritoneal carcinomatosis.....	13	
	33	19.1
(b) Gross carcinoma removed—with cure possible.....	112	64.7
Resection mortality.....		4.1
Over-all mortality.....		7.5

In Table VII is presented a summary of the management of the carcinomas of the colon. Twenty-eight patients, or 16.2 per cent, presented lesions in which resection was impossible or deemed not worth while because of the extensive spread of the lesion. In 145, or 83.8 per cent, the primary lesion was resected. In 33 patients, or 19.1 per cent of those resected, there was present gross carcinoma other than the primary lesion which was beyond the reach of surgical excision. Among these, 20 patients had hepatic metastases and in 13, there was extensive peritoneal spread. Thus, resection in this group can be only palliative in effect. In 112 patients, or 64.7 per cent, resection was carried out in patients in whom there was hope for cure. Lymph node involvement was of course present in many of this group. Exact studies of the extent of nodal metastases were not carried out and because gross methods of determining their presence are inaccurate their incidence is not definitely known. Previous studies by Collier, Kay and MacIntyre¹ showed involve-

ment of 62.5 per cent of nodes in resected carcinomas of the right colon and 60 per cent in nodes in resected carcinomas of the left colon. These findings are probably essentially applicable to the lesions here presented. The over-all hospital mortality for the entire group of 173 patients presenting themselves for treatment is 7.5 per cent. The mortality in patients in whom resection was carried out was 4.1 per cent. To summarize the causes of death, four occurred in patients having extensive resection of transverse colon or splenic flexure with stomach and jejunum in an attempt to remove widespread carcinoma, one occurred from a duodenal fistula following right colectomy, autopsy proving the presence of unremovable cancer. Had these patients survived, their hope for cure would have been exceedingly small. One patient died of sequelae following injudicious selection of operative method. Thus, among the patients in whom cure might be effected there was in reality only one death due to faulty technic presenting a mortality rate of 0.89 per cent.

These observations emphasize the fact that the surgical treatment of carcinoma of the colon susceptible to surgical eradication is much better than is our ability to get patients for treatment at a time when the lesion is removable. The outstanding need for better results is earlier diagnosis. The mortality of surgical treatment in patients with cancer of the colon when the lesion is localized is low. Surgical treatment of lesions that have spread from the primary source carries a higher mortality and small hope of cure.

COMMENT.—For many years we employed exteriorization operations in our clinic, first the Mikulicz procedure, then the Rankin obstructive resection with far better results. These procedures minimized the danger of peritonitis but they were marred by a multiplicity of operations, a long hospital stay, fecal drainage, infected wounds, and weak scars. Because of our dissatisfaction with these factors, we decided to attempt a more extensive use of primary anastomosis. In the treatment of carcinomas of the colon in this series, we have endeavored to perform resection with primary anastomosis whenever feasible. The question whether to perform a closed or open anastomosis confronts the surgeon. In this series we have used the open methods in 52 patients and the closed or aseptic method in 68 patients. The aseptic method has become increasingly more popular with our surgeons. It is felt that both methods are satisfactory; peritonitis is unlikely to occur from any local contamination of the peritoneum attendant upon the open anastomosis. Generalized peritonitis occurs from persistent leak of an anastomosis, severe wound infection or as a result of contamination by rare virulent organisms. The striking point of difference between the two methods is not that peritonitis is more apt to occur with one method or the other, but that with any open anastomosis there is a high risk of contamination of the abdominal wall with an increased risk of infection at that place. The peritoneum will withstand infection much better than will the abdominal wall.

In 1939, Collier and Valk⁶ presented before this Association the use of

CARCINOMA OF THE COLON

delayed closure of abdominal wounds that were contaminated by the contents of the gastro-intestinal tract. Pemberton and Black,⁷ and A. W. Allen⁸ since, have reported favorably upon the use of this method. In Figure 1, is illustrated the delayed closure of the transverse abdominal wound.

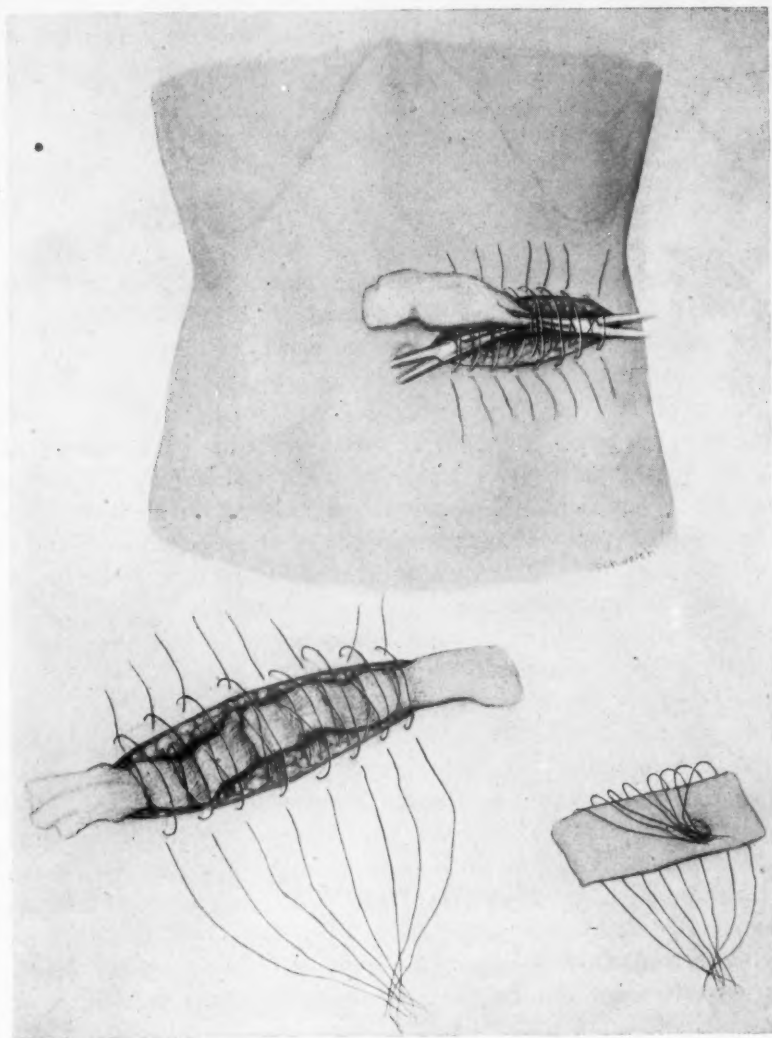


FIG. 1.—Delayed closure of skin and panniculus of a transverse abdominal incision. Showing gauze in place, which is removed and sutures tied in 48 hours.

The peritoneum and fascia are closed in separate layers. Gauze is placed in contact with the subcutaneous tissues. It is removed in 48 hours and the wound approximated by tying the sutures. We have continued to use delayed closure of the abdominal wound whenever open anastomosis has been used, whenever there has been gross soiling from the gastro-intestinal tract, and in closure of colostomies or other fistulous openings in the gastro-

intestinal tract with satisfactory results. In Table VIII, the results of delayed closure of contaminated wounds occurring in this series are shown. There was a resultant infection in 8.4 per cent but these were all minimal and did not lead to dehiscence of the wound or prolonged healing. The method has justified itself in our hands. The chief point in favor of an aseptic form of anastomosis is that the wound may be closed primarily;

TABLE VIII

INCIDENCE OF WOUND INFECTION USING THE DELAYED TYPE OF CLOSURE
WHICH WAS USED ONLY IN GROSSLY CONTAMINATED WOUNDS

1. Delayed Closure—71:		
(a) With infection.....	6	
(b) Without infection.....	65	
Per cent of infection.....		8.4

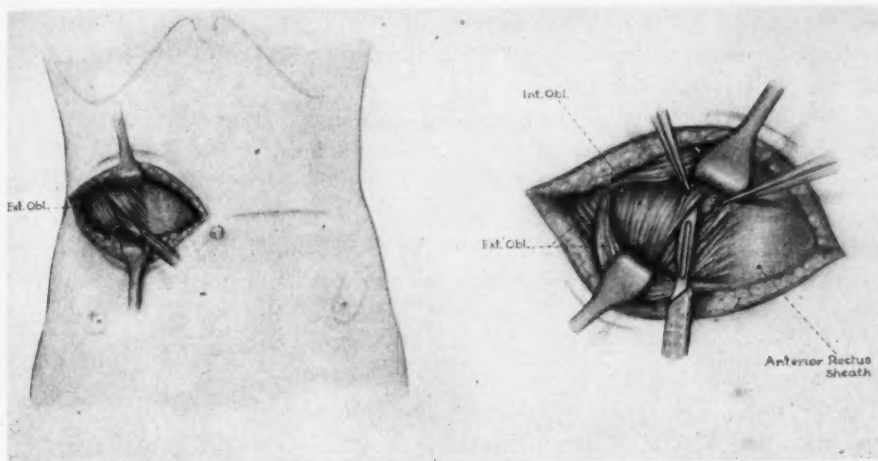
if the open method is used, one should assume that the wound in the abdominal wall is contaminated and delayed closure should be employed. In performing the closed type of anastomosis we have used clamps with a narrow blade, employing an outer layer of silk mattress sutures and an inner suture of fine catgut inserted by the Cushing right-angle method. Clamps are applied at a right angle, unless there is a discrepancy in the size of the lumen of the two segments. The bowel wall must have an adequate blood supply and be approximately normal in its histologic state if primary suture is carried out; tension must never be present; the bowel is never dissected from its appendages or mesentery in order to secure cleared serosa for approximation. The peritoneum covering the mesentery and the appendages will unite when approximated if the blood supply is undisturbed. The anastomosis is supported by peritoneal flaps and the omentum whenever possible.

In the closure of colostomies we have abandoned the use of crushing clamps applied to spurs. The colostomy is freed from the abdominal wall, an appropriate end-to-end anastomosis is made and the abdominal wall is closed by the delayed method. We have had no misadventures from the use of this method. It appears to us safer, simpler and time-saving as compared to other methods. Obstructive resection still has an important place in the treatment of carcinoma of the colon when the bowel, due to infection, obstruction or associated lesions, is not suitable for primary anastomosis, but to employ it routinely for fear of contamination of the peritoneum at the time of resection is not justified by this experience.

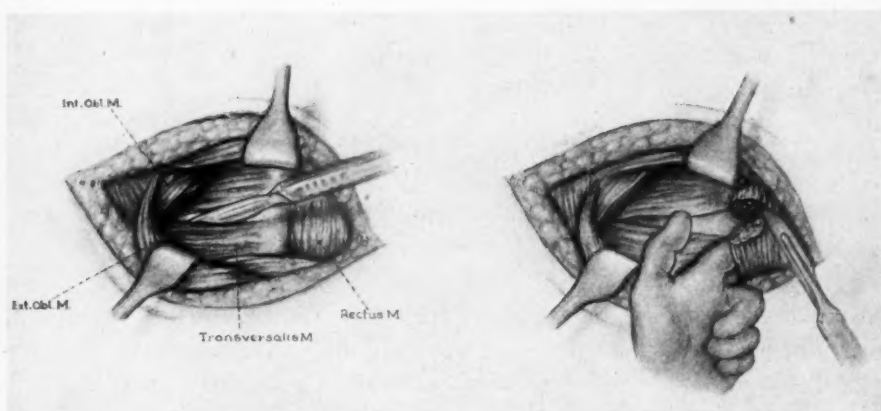
Stenosis of the bowel may occur following the contraction of the scar of a primary anastomosis. In three patients in this series this did eventuate a year or more after operation as shown by roentgenologic studies. In one instance a secondary resection was carried out with restoration of continuity by primary anastomosis; no carcinoma was found and the narrowing of the lumen was undoubtedly due to scar. In two other cases the narrowing in the transverse colon has remained unchanged and without symptoms for two years.

CARCINOMA OF THE COLON

Preoperative decompression is employed whenever obstruction is present. This is common in patients with lesions of the transverse or left colon. Of the patients with resectable lesions of the entire colon, 26 had preliminary decompression. Of these, nine had colostomies and 17 had cecostomies. If rapid relief from distention is desired, cecostomy is performed; if it



A



B

FIG. 2.—(A) Incision used for right colectomy. External and internal oblique muscles split in direction of its fibers. Left healed transverse scar used for ileotransverse colostomy. (B) Transversalis muscle split in direction of its fibers and rectus muscle cross-cut in part or in whole, depending upon exposure needed.

is thought that the colon is filled with solid contents and evacuation will be difficult and if the colon is not greatly distended a colostomy is carried out. We do not routinely defunctionalize the left colon by transverse colostomy before performing end-to-end anastomosis in that organ. In those cases in which obstruction was not present and upon whom resection with end-to-end anastomosis was carried out, a complementary cecostomy was performed in all but six patients and a cecostomy was performed following

operation on one of these because of distension. Cecostomy or colostomy before operation is necessary in obstructing lesions; complementary cecostomy adds to the comfort of the patient and is a worth while safeguard. The type of cecostomy performed is a slight modification of the Hendon enterostomy or an appendicostomy. Large tubes are not employed. The incision in the abdominal wall is of the muscle-splitting type placed laterally just above and slightly medial to the right anterior superior spine. The great majority of these closed spontaneously within a short time following removal of the catheter. It is a minor safeguard.

We have employed with increasing frequency, transverse incisions in the abdominal wall for operations on the colon until it has now become a routine. The level of the incision is varied to meet the site and situation of the lesion. In Figure 2 is illustrated the method used. The rectus sheath is cut across and a part or all of the rectus muscle is cut perpendicular to its fibers and the flat abdominal muscles are split in the direction of their fibers. This incision gives ready access to the right or left gutter and the colon. This incision lends itself well to obstructive resection as the bowel ends can be brought through the outer angle of the wound, without tumor, giving excellent exposure for primary anastomosis. Dehiscence of this type of wound has not occurred. Should infection supervene, the wound does not tend to separate; small intestine does not become adherent to such a wound as it may in those made longitudinally. The wound is more comfortable. We have practiced early rising following operation in patients in which obstruction or infection is absent, routinely, having them get out of bed on the day following operation. It is our belief that this maneuver shortens convalescence and adds to the comfort of the patient. Without endeavoring to present here statistically the advantages, one can say that the abolition of the catheter and bedpan from the post-operative period makes it popular with the patients and alone justifies the method.

The sulfa drugs were used locally and generally in a few patients treated in the early cases of the series. They have not been used locally in any cases operated upon since July, 1940, and they have been used generally only in those patients with peritoneal, urinary or pulmonary infection.

Sulfaguanidine and sulfasuxidine were used as a preoperative measure in a few cases but they have not been used as a routine. From previous experience we feel that the local peritoneal use of the sulfa drugs is unnecessary. The deliberate failure to use any of these chemicals is not an indictment against them but it is felt that the eventual valuation of their utility will be aided by providing a series of patients treated without their use as a series of controls. In no case was vaccination of the peritoneum by any method carried out.

In Table IX, is shown the average number of postoperative days of hospitalization following the different types of treatment. The number of patients in each group is not large enough to make these figures more

CARCINOMA OF THE COLON

than roughly indicative of the facts. Hospitalization of patients with closed anastomosis was shorter than of those with the open type of anastomosis. This was due to a greater incidence of wound infection following the open anastomosis. Even with the delayed method of closure there occurred 8.5 per cent of wound infection that prolonged the hospitalization. The average hospitalization time for patients with open anastomosis was lengthened by a prolonged hospital stay of three patients with severe wound infection in

TABLE IX
SHOWING AVERAGE POSTOPERATIVE HOSPITAL STAY WITH VARIOUS TYPES OF
SURGICAL PROCEDURES FOR CARCINOMA OF THE COLON

End-to-end anastomosis—closed.....	16.3 days
End-to-end anastomosis—open.....	26.7 days
Obstructive resections.....	60.9 days
One-stage right colectomies.....	14.0 days
Two-stage right colectomies.....	18.0 days
Palliative (nonresectable) lesions.....	20.5 days

which delayed closure was not employed. The contrast between hospitalization time of patients with obstructive resections and those with direct anastomosis is striking. In determining hospital stay for patients with obstructive resection, we have included the time of the second entry for closure of the colostomy. The difference in hospital stay between the one- and two-stage right colectomy is not striking and the slightly longer hospital stay of patients with the two-stage operation is not an important criticism of it. The length of hospitalization before operation was not tabulated as it varies so much with conditions of disease and its complications. The utmost importance of careful and thorough preparation of patients for operation has been so well and frequently discussed that the details need not be further emphasized. Suffice it to say that decompression of the bowel must be complete, the patient's nutritional deficiencies overcome, insofar as is possible and anemia corrected by transfusion, thus making the preoperative time element entirely dependent upon preparation.

SUMMARY

A series of 173 patients with carcinoma of the colon treated by operation is reported.

Of these lesions 16.2 per cent presented lesions beyond the reach of resection and for whom only palliative operations could be carried out. Resection of the primary lesion was undertaken on 83.8 per cent of the patients. Of the patients upon whom resection was carried out 19 per cent had other gross metastases in the liver or peritoneum that were beyond surgical removal. Therefore, the resections in this group were palliative in nature.

In 112 patients, or 64.7 per cent, resection was undertaken without evidence of gross carcinomatous spread beyond the lymph nodes; in these cure might be hoped for. Death occurred in only one patient in the group in which there was a chance of operative cure. Deaths occurred from advanced disease or following operative attempts to remove widespread

disease. Surgical treatment of carcinoma of the colon will be further advanced by earlier diagnosis of the disease. Surgical methods must be individualized to meet the varying conditions of disease.

Primary resection with end-to-end anastomosis is feasible in many patients and offers many advantages. A complementary cecostomy is a wise safeguard if a proximal vent has not been previously established. Open or closed types of anastomosis are equally suitable without fear of peritonitis unless the anastomosis breaks down. The abdominal wall is often contaminated during the operation of open anastomosis and wound infection is greater than with aseptic methods of union. When the abdominal wall is contaminated, delayed closure of it minimizes the chance and degree of infection. The value of the transverse incision is mentioned. None of the sulfa drugs were employed routinely and this series may be used as a control in future evaluation of methods of treatment.

Improvement in the results of surgical treatment of carcinoma of the colon will come largely from earlier recognition of the disease.

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DISCUSSION.—DR. ALBERT O. SINGLETON, Galveston, Texas: We appreciate the able presentation of this subject by Doctor Collier. His success is quite notable. Only a few years ago one was considered to be breaking a cardinal rule of intestinal surgery if he resected any part of the left half of the colon in a one-stage operation. At the present time resections and end-to-end anastomoses of the bowel are done with apparent great safety, with a lower mortality and a great saving of time for the patient. The excellent results which are being secured with this type of procedure are not necessarily due to the new drugs, such as the sulfonamides, as claimed by some, but to the application of new principles during the last decade. These principles consist of: first, a proper regard for the circulation of the bowel with careful approximation of viable tissues, preferably with a closed type of anastomosis; second, putting the alimentary tract at complete rest for a period of days subsequent to resection by the use of gastric suction which, if properly used, prevents gaseous distention; and, third, proper care of the patient's fluid balance, electrolytes and food requirements, including glucose and proteids administered parenterally.

I also agree with Doctor Collier in his stressing the importance of proper regard for the abdominal wall, with reference not only to infection but more particularly to anatomic incisions. We have not found it necessary within the last few years to use a proximal enterostomy for decompression but depend entirely upon gastric suction.

CARCINOMA OF THE COLON

DR. FRANK P. STRICKLER, Louisville, Ky.: It is certainly a good break for the patient and surgeon when a primary anastomosis of the large bowel can be done, but in a fairly large experience with this type of surgery, how often does this situation present itself? No suture line is better than the blood supply to the part. I do not believe that colon cases should be permitted out of bed in 48 hours. Why ruin a good operation with bad judgment? The colon does not heal that fast.

I do not know positively how much good the sulfa drugs do in colon surgery, but, to date, I see no reason for not using them. We at least know that properly given they do no harm, so I will continue to use sulfa drugs in my colon surgery. The patient deserves every safety factor available.

We are deeply indebted to Doctor Lahey for his resection of the right colon. This operation has many applications. I have used it for extensive gunshot wounds, intussusception, regional ileitis, as well as malignancy. I know that some surgeons object to this operation, but in my hands it has been a life-saver in more than one case. The operation is performed with no special instruments; it can be done rapidly and with very little shock. I find it a very satisfactory and safe operation.

DR. JOHN DEJ. PEMBERTON, Rochester, Minn.: I enjoyed Doctor Collier's presentation very much but I do feel that sufficient credit is not being paid to chemotherapy. In the fall of 1939, at the Mayo Clinic, we began using sulfanamide compounds in colon surgery in a rather casual manner, occasionally placing 5 to 10 Gm. in the peritoneal cavity prior to closure of the wound in cases in which peritonitis was feared because of actual or suspected soiling. Later, as experience enlarged, we began using them more routinely. In 1942, following the work of Poth and Firor, succinylsulfathiazole was employed routinely as a preparatory measure. Other than the use of chemotherapy, there has not been any major change in the management of colonic and rectal carcinoma at the Clinic during the past ten years. The hospital mortality rate of all patients with carcinoma of the colon and rectum during the period 1934 to 1943, inclusive, was computed on the basis of the number of patients who had been operated upon; that is, whether they had a resection, a palliative procedure or only an exploratory operation. As the graph in Figure 1 reveals, the mortality rate before 1934 varied between 15 and 20 per cent. A slight drop occurred in 1939, the year in which sulfonamide compounds were first used intermittently; then in 1940 there was a precipitous drop to around 5 per cent, and the rate has since dropped more. During this period of decline in the mortality rate, there has been no decline in the rate of resectability but instead, as indicated in the graph in Figure 2, there has been an appreciable increase.

The changes that have occurred in surgery of the colon since the introduction of chemotherapy have been as spectacular and revolutionary as the changes wrought by iodine therapy in surgery of exophthalmic goiter. The striking analogy has often occurred to me. Just as in the pre-iodine era of thyroid surgery the technical perfection of the surgical procedure of partial thyroidectomy was no definite assurance that the patient would endure the operation (for not infrequently a severe hyperthyroid crisis would supervene, resulting in death), so in the prechemotherapy era of colonic surgery the technically errorless resection of a segment of intestine was not definite assurance that the patient would survive, for not infrequently infection would spread and produce fatal peritonitis. The surgeon in both fields, after resorting to refinement of technic and other measures, finally learned that the best means of combating the hidden danger (acute hyperthyroidism on the one hand and the spread of infection on the other) was to divide the operation into stages. In both fields the employment of the two-stage procedure resulted in great improvement but only partially eliminated the hidden danger peculiar to each. Thus, it was only after preoperative iodine therapy had been standardized that the surgeon could be reasonably assured that, barring some accident, the patient with exophthalmic goiter would endure an uncomplicated partial thyroidectomy in one stage. And, so, in the field of colon surgery, only in recent years, since the advent of chemotherapy, could the surgeon be reasonably confident that the patient with carcinoma of the colon or rectum would survive an uncomplicated operation for resection of the colon.

DR. FRANK H. LAHEY, BOSTON, MASS.: Doctor Collier's approach to this problem of carcinoma of the colon is an excellent one because we need to demonstrate again and again what can be done in these cases and what more could be done, if we could

get earlier diagnoses. If we start at the very beginning, the logical approach to this problem of carcinoma of the large bowel is more frequent contrast enemas and more frequent good sigmoidoscopic examinations to discover polypi. We must find polypi more frequently than we do if we really want to approach this problem of cancer of the colon and rectum earlier, because polypi are such real precancerous lesions.

I have repeatedly reported Doctor Swinton's interesting approach to this problem because there is such a lesson in it. Before going in the Army he was particularly interested in the earlier diagnosis of these cases. He took 100 cases of cancer of the right colon in the clinic, proven by removal, 100 cases of cancer of the left colon proven by removal, and 100 cases of cancer of the rectum proven by removal, and asked, not the patient but of the history—"Was there blood in the stool? Was there alteration of bowel function and was there pain of an obstructive character?" The answer was "Yes" in all but 2.3 per cent of the cases. In other words, in 97.7 per cent of the cases the diagnosis, or at least the suspicion of it, was in the history.

I do not wish to consider the technical approach because one can do the same radical operation either by the modified Mikulicz procedure or by primary anastomosis. It is largely a matter of personal opinion. I think you would be much more interested in end-results. Having recently reported on our end-results at a meeting of the Massachusetts Medical Society, I would like to present them to you. We have now operated upon 1800 patients with carcinomas of the colon and rectum; of these, 70 per cent were in the rectum and 30 per cent were in the colon. The total mortality of the entire series, including the early cases, was 10.25 per cent. The mortality in the last 5 years for the entire group was 5 per cent. The mortality in the last two years was 2.7 per cent for carcinoma of the colon and 3.8 per cent for carcinoma of the rectum. The five-year nonrecurrence rate of the entire group of patients who have been submitted to the radical procedure was 50 per cent. If we break this group down into special groups, it illustrates something that we know and have known quite well, that is, it is not the size of the lesion that makes the inoperability; it is particularly the invasion of blood vessels. If we take the group with no lymphatic metastases, no invasion of adjacent organs and no blood vessel invasion, 90 per cent are alive and well over five years, with no recurrence; if we take the group with only lymphatic metastases, 37 per cent are alive and well over five years without recurrence, and if we take the group with involvement of other organs, 30 per cent are alive and well over five years without recurrence. If we take the group with blood vessel invasion, however, only 14 per cent are alive and well over five years after operation.

It will be of interest to demonstrate by follow-up figures whether or not removal of the lesion in the presence of metastases in the liver is worth while. The average length of life of patients with metastases in the liver without the lesion removed is 14 months, while the average length of life of the patient with metastases in the liver and with the lesion removed is 25.5 months. This demonstrates, it seems to me, quite conclusively that, unless the metastases in the liver are extensive, if the lesion is removable it is worth while to resect it even though there be metastases in the liver. In 9.5 per cent of the patients upon whom we have operated there have been metastases in the liver.

Medicine and surgery can be proud of, but not satisfied with, the results of operations for carcinoma of the colon and rectum. I must again stress the fact that we need particularly to educate the internists and the general practitioners to investigate these patients early for polypi and to stress particularly to the general practitioners and to the public that the presence of the three features which we have described as indications of the presence of possible malignancy of the colon and rectum—alteration in bowel function, blood in the stools and pain of an obstructive character—should cause these patients to be submitted to a complete gastro-intestinal roentgenologic series, contrast enema and sigmoidoscopic examination.

We have just had an interesting experience which demonstrates what has happened in regard to polypi in a group of bank officials sent to us for complete physical examination. Out of the first 25 men in this group sent to us, four had polypi. This is a much higher incidence than we all know regularly exists, but demonstrates that this lesion, which is undoubtedly in many instances a precancerous lesion, is much more prevalent than we think it is, and it is, of course, the stage at which cancer of the rectum and colon should be treated if possible.

CARCINOMA OF THE COLON

DR. FREDERICK A. COLLIER, Ann Arbor, Mich. (closing): I want to thank you for your discussion of this paper, and to emphasize our position in regard to the sulfa drugs. We deliberately refrained from using them in this series of cases so there would be a control group, and we invite comparison between this and other similar groups in which the sulfa drugs have been used. I am convinced that sulfas in the peritoneal cavity are not worth while and I am, likewise, convinced that their use in the abdominal wall is harmful. I believe sulfasuxadine has a real place in the preparation of these patients and we are going to use it now that this series is finished.

FIG. 1

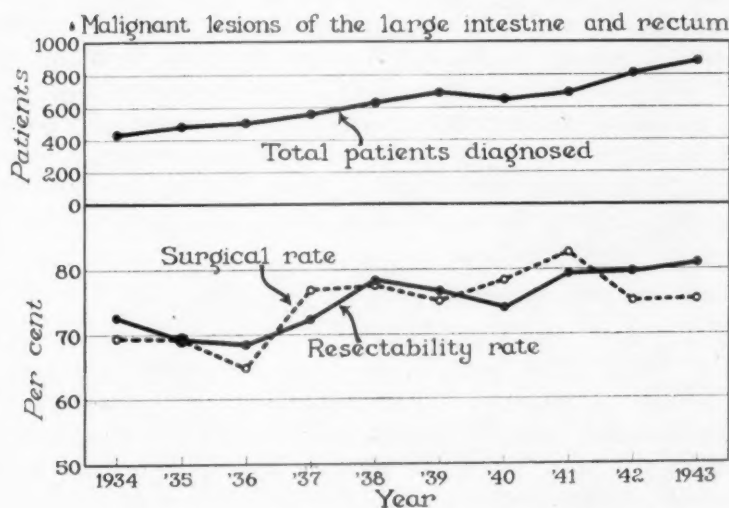
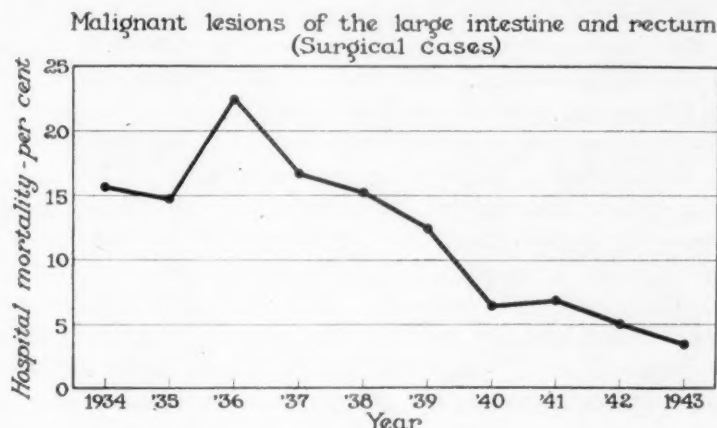


FIG. 2

I want to emphasize what Doctor Lahey has said about early diagnosis through knowledge of the history of the disease and frequent examinations with the sigmoidoscope, and routine barium enemas. Surgical treatment is far more efficacious than is our ability to make an early diagnosis when the chance for cure is good. In this series of cases fatalities occurred from far advanced disease or from heroic surgical treatment carried out in a vain attempt to cure the hopeless lesion. The mortality from operative treatment of localized cancer was exceedingly low. Primary resection with direct anastomosis is feasible in a high percentage of cases.

A METHOD OF RE-ESTABLISHING CONTINUITY BETWEEN THE BILE DUCTS AND THE GASTRO-INTESTINAL TRACT*

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SO MANY OPERATIVE PROCEDURES for the re-establishment of continuity between the biliary passages and the gastro-intestinal tract have been recorded that one hesitates to offer another possible solution to this difficult and complicated problem. I have had so many disappointing sequelae, following the use of what appeared to be the most logical reconstruction for that particular patient under the conditions at the time, that much thought about the whole situation has led to certain deductions.

Many excellent contributions have been made to this subject. The most noteworthy of recent years are represented by the exhaustive report by Ellsworth Eliot, Jr.¹ in 1936, the excellent presentation before this Association by Lahey² in 1936, the work of Pearse³ on the vitallium tube, the method of Wilson⁴ and that of Dragstedt, *et al.*⁵ Every surgeon should read Sir James Walton's⁶ superb article in *Surg. Gynec. and Obst.* for July, 1944. The delightful style of this presentation would make interesting reading to any intelligent person whether he be student or master surgeon.

I wish to point out here that I do not plan an exhaustive review of this entire subject and, therefore, hope that many important reports not mentioned will not cause offense. It seems unjustifiable at this time to repeat or even bring entirely up to date the complete complication of Eliot.¹ I desire to discuss the difficulties encountered in some of the procedures I have tried and to present a preliminary report on a method I have found satisfactory in a small group of cases. Some of these had been operated upon by other methods by me, some by others, and most of them several times and by several surgeons.

PREVENTION OF DUCT INJURY

First, and most important of all, is the obvious responsibility of every surgeon to practice and teach the need for the greatest possible respect for the simple "gallbladder." The operation of cholecystectomy is one that is commonly considered within the scope of the surgeon of little experience in this field. These men are often unaware of the high percentage of anomalous arrangements of blood vessels and ducts in this region. Death following cholecystectomy is often thought to be due to causes beyond control and remote from the operative site, yet, doubtless, many are due to unrecognized bile peritonitis or necrosis of the right lobe of the liver. The so-called "liver deaths," once considered due to an unremediable lack of reserve on the part of the patient, were probably often the result of

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RECONSTRUCTION OF BILE DUCTS

ligation of the right hepatic artery under the impression that it was the cystic artery. The frequency of these anomalies was first brought to our attention by Eisendraht.⁷ Browne,⁸ and others, have made further important contributions to this subject. So commonly does one find an arrangement that varies from the so-called normal, that one should constantly be mindful of such possibilities. Fortunately, many of the anomalies are not of such a nature as to interfere with a routine procedure. Some of them, however, are sufficiently important to make a difference between life and death and many will leave a patient in such a condition that I have often wondered whether life as it had become for that particular victim was not worse than death.

This means that every surgeon must obtain adequate exposure of this region. Sufficient dissection of the area must be carried out to identify beyond question every structure that is vital to leave uninjured, and divide only those accompanying the gallbladder itself. Several years ago, I reviewed all the case histories of patients entering the Massachusetts General Hospital with operative injuries of the bile ducts. In every instance, save one, when the type of operation could be ascertained, the surgeon had removed the gallbladder from the ducts towards the fundus. This led me to believe that perhaps it was safer to remove the gallbladder from the fundus toward the ducts. Consequently, I worked out a meticulous technic with artificial edema in the gallbladder peritoneum, which has been used almost exclusively by the resident staff on the East Surgical Service of our clinic for about six years.⁹ During this interval, many anomalies have been recognized and no injuries to the common or hepatic ducts nor to the hepatic arteries have occurred. It is only fair to say that I am not aware of any such catastrophes on the West Service, where they have continued a preference for the dissection from the ducts towards the fundus. Others feel that the operation can be performed just as safely, or even more so, from below upwards. The advantages, particularly of ligating the veins and small accompanying accessory ducts leading from the gallbladder directly into the liver, are certainly worth considering. It is also easier to preserve the peritoneal-like capsule of Glisson in the liver bed if the dissection is from above downward. Often no effort is made to preserve this tissue and it is amazing to see the number of surgeons who apparently have never heard that it could be saved or that such a protective structure actually existed. In fact, a method of routine cholecystectomy has been advocated that leaves the posterior wall of the gallbladder attached; the mucosal surface of which is dissected by electrocoagulation. Frequently, when the dissection is done from the ducts to the fundus, the posterior peritoneal layer becomes accidentally detached from the liver bed, even if only mild upward traction is used on the severed cystic duct. The real disadvantage to the operation from the fundus towards the ducts is that it requires meticulous hemostasis and, therefore, the operating time is increased. Unless the field is dry and clear vision of structures obtained,

the chief indication for this approach is lost. The object is to expose the cystic artery, cystic duct, and at least the common hepatic duct before any important structure has been clamped or divided. It is obvious that the approach is not the important feature but the accuracy with which one identifies the structures to be severed. It seems clear to me that men of less experience should select the type of operation to be undertaken according to the ease of access to the duct region. Then they will not find themselves in a field obscured by bleeding and be faced with uncertainty regarding the structures they have interrupted. In many of the injured duct cases, we obtain the story of a difficult dissection in a bloody field. On the other hand, it is surprising how often the surgeon states that he is sure the common duct could not have been injured because the operation was so easy and went so well.

The second obvious attitude should be early recognition of duct injury. Occasionally, a surgeon will ask for advice by telephone regarding the proper steps to take, having recognized an injury to the common duct, the first in many years of surgical practice. The repair can usually best be made at the time of injury. If not then, as soon as the patient can be safely moved to another hospital. During this interval, liberal external drainage is important. Often the bile flow can be completely controlled by the temporary insertion of suitable tubes. Unless the surgeon has had experience with the repair of ducts, he may wish to give this responsibility to someone else. Too often, a poor repair results in failure and the surgeon suffers as much as the patient. A careful approximation of the ends of the ducts without tension, with nonabsorbable interrupted sutures, will usually give a good result. This can be made easier if done over a suitable tube. It is better to plan on removal of the tube and a separate incision in the duct proximal to the suture line is advised. One may use a T-tube or Horgan's L-tube for this purpose to advantage. One should have in mind the eventual minimum of scar tissue at the site of the anastomosis and avoid, if possible, the additional trauma produced by the removal of the tube if placed in the suture line. Tubes have been left within the duct and not through the papilla of Vater. Such a tube will eventually become incrustated with bile salts whether it is of rubber or vitallium. Long tubes placed well into the jejunum will often spontaneously pass in time but, on one occasion, I had to remove such a tube 14 months after its insertion.

TYPES OF INJURY

The victims of injured bile ducts fall into two main groups: 1. The type that either becomes jaundiced within a few days after operation or drains an unexpected amount of bile into the peritoneal cavity or to the outside. 2. Those patients who do moderately well for some weeks or even months before developing signs of jaundice with beginning episodes of chills and fever.

In the first group, we have patients who have had ligatures placed upon the cut-ends of the ducts with resulting jaundice, usually being

temporarily relieved in a week or ten days by the sudden outpouring of large quantities of bile. Others in this group have an immediate reaction characteristic of bile peritonitis from which at least 25 per cent die¹⁰ or, if drains were adequately placed, the discharge of an abnormally large quantity of bile to the outside. In the group with ligatured ends, the situation may be recognized and corrective surgery instituted before the sutures give way, resulting in a possible fatal bile peritonitis. This accident is most apt to take place where the cystic duct is short or runs into the common duct at a low level. Traction on Hartmann's pouch (ampulla of the gallbladder) brings into view a normal-sized common duct that under tension seems to the operator small enough to be the cystic duct. It is difficult to understand how the surgeon can tie the same duct at a higher level, which he must do in order to get the gallbladder free, without recognizing his error. Probably, he mistakes the upper segment of common duct for the cystic artery. At any rate, I have removed chromic catgut ligatures placed one month before on the proximal and distal ends of the common duct separated by a gap of four centimeters. So much of the duct was missing that mobilization to allow end-to-end suture was impossible. In this case, after an unsatisfactory year of life with reconstruction over a vitallium tube, there has been complete relief obtained by the method I will describe later. Another type of injury, falling into Group 1, is that produced by sufficient tenting of the common duct to allow complete division of this structure. This injury results in a condition lending itself best to an end-to-end anastomosis.

In Group 2, we have the partial strictures that take place when the duct is tented sufficiently to constrict only its anterior portion. Also, in the instance of hurried, blind, hemostatic control of unexpected hemorrhage, the duct may be injured in such a way as to produce a slow stricture with resulting characteristic signs and symptoms. This second type of injury can always be avoided if the surgeon will go to the left side of the patient and place the fingers of his left hand into the foramen of Winslow. By exerting gentle upward pressure, the bleeding is completely controlled until the exact source of the hemorrhage is determined and accurately secured. I have witnessed a brilliant young surgeon spend one hour in the accurate replacement of a slipped cystic artery hemostat when five minutes spent on the opposite side of the table would have sufficed.

If partial duct injury occurs, a gradual onset of symptoms finally brings about complete invalidism. This group of patients will present themselves for help from 6 to 18 months after their first operation. Under these circumstances, one can expect to find that the distal segment of duct is narrowed and often sclerosed to a fibrous cord. On opening the duodenum, one finds the papilla of Vater but may not be able to get the finest probe through it. Experiences such as these have led me to feel that in Group 2, one should abandon any hope of finding a sufficiently normal distal segment to warrant attempts at end-to-end anastomosis. In this group, one finds

that the reconstruction procedure, which I am about to describe, of real value. When one abandons the distal segment of the duct and attempts anastomosis between the proximal dilated segment and the gastro-intestinal tract, there are certain principles that must be understood or a high percentage of failures will result.

PRINCIPLES INVOLVED IN RECONSTRUCTION OF BILE DUCTS

That man can not duplicate nature's connection between the biliary system and the gastro-intestinal tract is obvious to all who have attempted

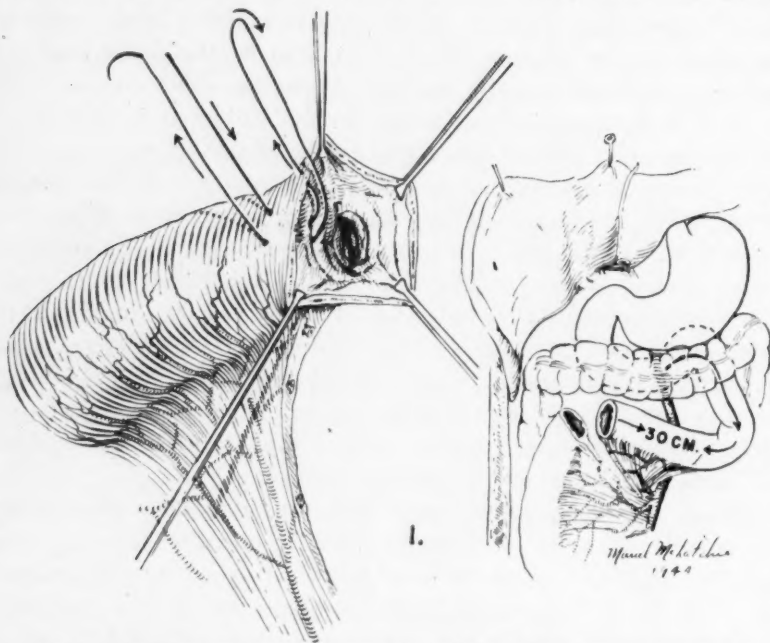


FIG. 1.—Schematic drawing representing the division of the jejunum approximately 30 cm. distal to the ligament of Treitz. Also, the method which is used to invert the end of the distal segment.

it. When we think of the ease with which permanent anastomoses are made in the gastro-intestinal tract with effective by-passing of its contents, it seems strange at first that such is not the case between the biliary system and the intestine. One is familiar with the term "sphincter of Oddi" and much has been said about preserving its integrity. Recently, Gordon-Taylor¹¹ has challenged the sphincter mechanism of the outlet of the bile duct and stated that there are only longitudinal and oblique muscle fibers in this region. He believes that any control of contents from the bile ducts into the intestine would have to be explained on the basis of an erector influence of these muscle fibers on the papilla. It is known to us that the duct passes through the duodenal wall in an oblique direction and that we can stretch or cut these muscle fibers with impunity when the occasion demands. It seems that nature has protected us from serious injury in this respect. The oblique direction of the duct through the duodenal wall, which is

RECONSTRUCTION OF BILE DUCTS

further supported by the adjacent pancreas, may leave an overhang of duodenal mucosa to act as a flap valve. This may explain the infrequency of "duodenal reflux" and "ascending cholangitis" when the normal relationship between the ducts and the duodenum are maintained.

Why anastomoses between the gallbladder or ducts to the gastro-intestinal tract so often result in cholangitis is not easy to understand. Certainly, two factors are worthy of consideration. The peristaltic action of the gastro-intestinal tract will send its contents into the liver ducts

FIG. 2

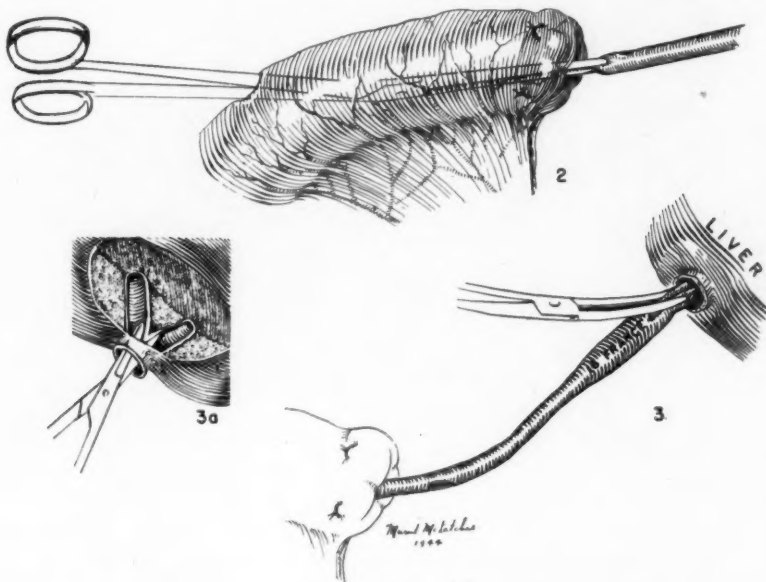


FIG. 3

FIG. 2.—Schematic drawing to illustrate the turned-in distal segment of the jejunum and how the catheter is brought down through the lumen of the intestine.

FIG. 3a.—Illustrates a method used in three instances to increase the depth of the hepatic duct so that at least 1 cm. of the bell end of the catheter could be held into the remaining segment of the duct. Note the eye cut in the catheter to allow bile to seep into the intestine instead of all coming through the tube to the outside.

FIG. 3.—Illustrates the method of introducing the bell end of the catheter into the developed segment of the hepatic duct.

under certain circumstances. This has been observed in spontaneous fistula as well as in artificial connections, when an opaque medium is seen under the fluoroscope to leave the gastro-intestinal tract and outline the hepatic duct system. That irritating substances as well as bacteria may accompany such material is easy to understand. Disabling symptoms associated with mild jaundice, fever, and chills not always occurs under these conditions. Mild cholangitis with little subjective or objective symptoms and signs may occur under all abnormal circumstances. Some such patients have little disability from these mild episodes and are doubtless included in those reported as completely relieved. On the other hand, many of them are temporarily invalided with each recurrence and finally develop continued jaundice, which varies somewhat in intensity with each acute flare. Under

rest, diet, cholagogues, *etc.*, a regimen may be worked out to prevent hemorrhagic tendencies and a modicum of comfort. These victims are too often relegated to an incomplete life and early death on the basis of liver damage. In these patients, we do not always find adequate proof of ascending infection as the important factor in producing recurring attacks of cholangitis. More often, a constricted area preventing free flow of bile into the intestinal tract is the chief cause of difficulty. It is quite likely that we will find that such individuals can be cured by an operation

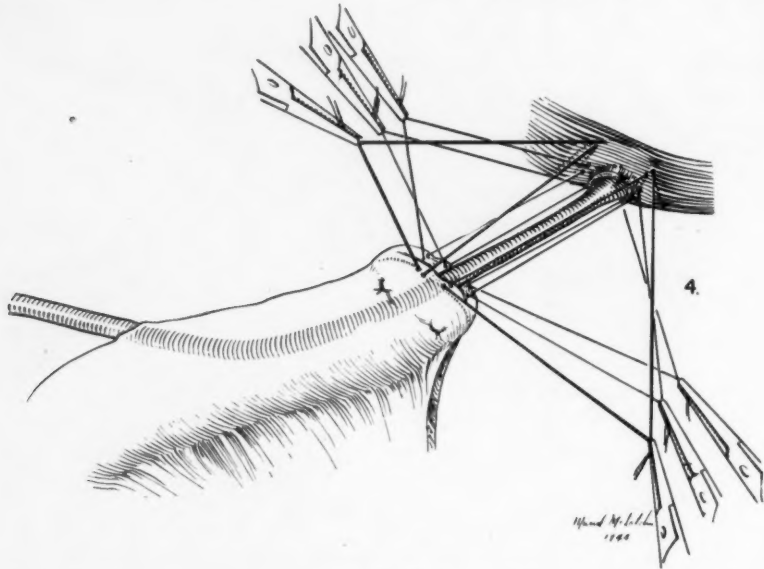


FIG. 4.—Schematic representation of sutures of No. 30 cotton thread placed through the scar tissue in the liver sulcus and through the jejunum. The bell end of the catheter has been fastened to the stump of the hepatic duct by two plain catgut sutures.

that does not in itself permit gradual scar-tissue obstruction. In all of these patients, we find a narrow communication between the biliary system and the intestine with inspissated bile or actual stones above it, contributing to the inflammatory symptoms observed.

All of the successful operations to restore continuity between the biliary and gastro-intestinal systems are based on a **wide**, free, permanent communication. The first operations were not successful because stricture eventually took place. In 1905, W. J. Mayo¹² reported a method of accurate mucosal anastomosis between the bile duct and the duodenum. Illustrations showed that a valve-like flap of duodenum was attempted. This operation has been performed extensively by Walters,¹³ with good results in at least 50 per cent of the cases. Many other surgeons have tried it with about the same percentage of cures. That this operation has not been completely successful is evidenced by the large number of plastic procedures recorded that appeared to be more rational.

Williams¹⁴ successfully implanted an external biliary fistula into the

RECONSTRUCTION OF BILE DUCTS

duodenum of a boy, age four. This fistula had been made in the early weeks of life for congenital atresia of the bile ducts. This patient has been recently seen and is in good health 30 years after his reconstructive operation. This case led to many attempts to solve this problem in adults in this manner. Most of them failed and cicatricial obstruction resulted, due to the fact that the fistulous tract had not spontaneously become lined with tissue resembling normal mucosa. The operation of Wilson, who advocated

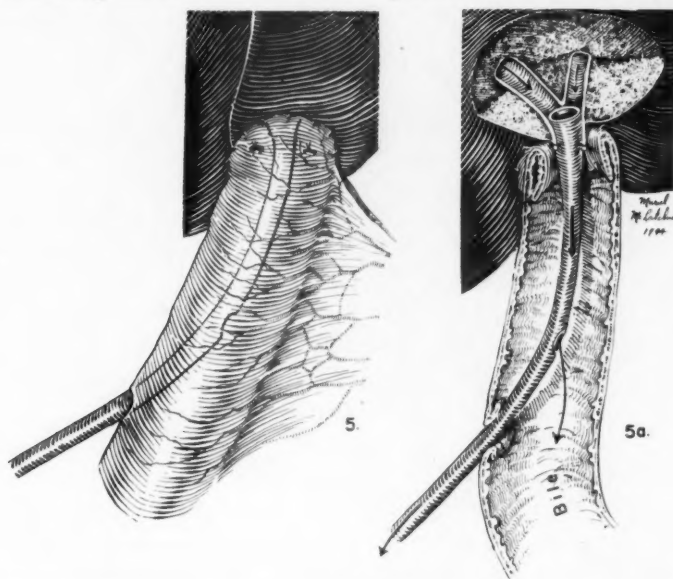


FIG. 5.—Illustrates the appearance of the jejunum after the sutures to the liver surface have been tied.

FIG. 5a.—Schematic representation of the approximate appearance of the tube *in situ*.

making a serous-lined tube from the stomach, seemed a logical step and yet we found it unsuccessful for reasons hard to explain. Dragstedt⁵ advocated the use of the duodenal wall, much as Wilson had used the stomach, and had one successful case to report. Dragstedt,¹⁵ however, has given what I believe to be important light on the subject from his work on the management of the pancreatic duct by intubation in operations requiring removal of the head of the pancreas. Sir James Walton⁶ illustrates a plastic operation using a flap of duodenal wall. Procedures such as Wilms¹⁶ and Sullivan¹⁷ proposed of using an omental graft around a tube are obviously doomed to failure in most instances.

Whatever method is adopted, one must consider the following points:

1. The elimination of scar tissue and preventing of its recurrence at the anastomosis.
2. To make the anastomosis iso peristaltic with the gastro-intestinal tract.
3. Nonabsorbable interrupted sutures should be used.
4. Water-tight closure at the anastomosis is desirable.
5. The anastomosis should be temporarily held open by a tube.

Research along these lines, beginning in 1937, has been interrupted by propositions that seemed logical and easier than the one I am to report. Thus, Wilson's method and modifications of it were tried in the interim. The most significant change in principle came about through the vitallium tubes, as proposed by Pearse.³ This appealed to me as the probable answer to the problem, and it was only after considerable trial on my own part, with

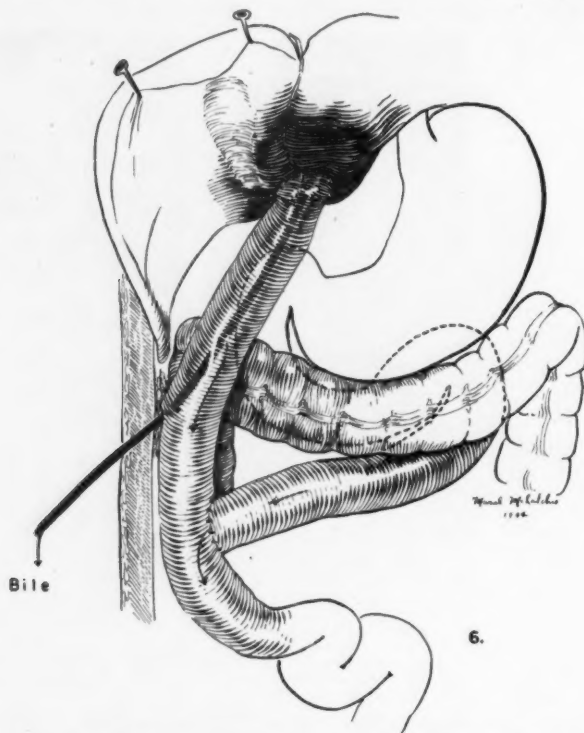


FIG. 6.—Schematic representation of the finished operation. The proximal end of the jejunum has been reimplanted into the side of the distal end at a low level; and the tube in the hepatic duct brought out through an omental tab; and a stab wound in the abdominal wall lateral to the incision.

the removal of several of these tubes inserted by myself and others, that I came to realize that this method had its limitations. Theoretically, it should work since there is the establishment of a more normal relationship between the ducts and the intestine. Actually, there is always a temporary respite. Bile salts do finally become deposited within the tube and thus gradual interference with bile-flow does occur with frequency. With the use of a permanent tube, one is faced with the impossibility of any dilatation of the duct. This in itself is abnormal, since the ducts have a natural tendency to dilate and thus partially take over the function of the gallbladder. Also, it is difficult to prevent the tube from passing down the intestinal tract if one end is left free in the lumen of the gut. Bile salts, administered freely postoperatively, are helpful in keeping the tube clear but have not been entirely effective in my experience. This rigid tube is of value in bridging

RECONSTRUCTION OF BILE DUCTS

an unresectable area of primary carcinoma of the bile duct. One such patient of mine lived nearly two years, for the most part in comfort, under these circumstances.

METHODS OF REPAIR

As I have intimated in the foregoing paragraphs, it is desirable to anastomose the cut-ends of the ducts by direct suture. This is applicable only to interruption by division or to a small suitably situated constriction. Anastomosis may be possible months after injury since the distal segment often maintains a normal diameter. When there has been the loss of a considerable portion of the duct, it is not worth while to attempt to bridge the gap by any artificial means. Sutures under tension or of absorbable material are very likely to fail. One can often prophesy that the result will be unsatisfactory from the prolonged leakage of bile to the outside when a poor anastomosis has been made. Repair by second-intention healing will invariably result in gradual cicatricial occlusion in the region of the suture line.

When there is gradual occlusion of the duct, one may expect that the distal segment will become fibrosed, resulting in little or no lumen. It is unreasonable to expect that this segment can be modified in any way to form the basis of a successful reconstruction. Thus, in all cases in Group 2 and in those in Group 1 with too much duct missing, one must resort to a logical procedure that fulfills the five principles of duct repair that I have set down. That many of the already proposed plans will give a satisfactory result in a certain percentage of cases is admitted. I have had so many failures and attempted to correct so many unsuccessful procedures undertaken by others that I have come to the conclusion that the method I wish to present may prove to be the most satisfactory I have so far tried.

In eight instances now, I have developed the short segment of hepatic duct in the liver sulcus and anastomosed the open distal end of the transected jejunum to the liver around a tube placed into the duct. Intestinal continuity is reestablished by implanting the proximal segment of jejunum into the distal segment after the method of Roux. This results in a mechanical arrangement whereby the intestinal current is directed away from the liver. Cotton or silk sutures hold the end of the jejunum securely in the liver sulcus since the scar tissue around the duct opening is very firm and reliable. By inverting the end of the jejunum for a distance of 1.5 cm., we have an opportunity to place in apposition two surfaces that, theoretically at least, have healing properties. One may question the fact that a small stump of duct whittled out of scar tissue will have any serosal coat remaining. By the use of the bell end of a live rubber catheter, one can expect to lead all bile through such a tube and thus produce a water-tight anastomosis. By making a vent in that segment of the catheter to remain for a time within the lumen of the gut, we can prevent a complete external fistula for as long as we leave the catheter in place. I have experimented with leaving

the tube *in situ* for variable periods of time. One would like to get rid of it early so that all the bile would flow into the jejunum. On the other hand, it is well known that tubes removed too early may be responsible for early scar tissue constriction. This has made it mandatory in many other types of reconstruction to leave the tube in place for a long period of time, *i.e.*, several months. This is practical in some repairs as is borne out by the better results obtained under these circumstances. The tube is supposed to keep the anastomosis open until healing is complete and the result of inflammation replaced by more normal tissue. In our cases, we feel that leaving the tube for a long time might result in some pressure necrosis of the duct lining. For this reason, the caliber of the tube used within the duct segment is carefully selected. The majority of our tubes have been removed at the end of 21 days. This is a compromise, and we may find reasons for shortening or lengthening this period of time.

In none of the eight cases has there been any bile leakage about the anastomosis. In three additional patients with huge common ducts, due to obstruction in the head of the pancreas, in whom we used the general principles of the above technic, we thought some leakage might occur but our suture lines, being placed in structures more nearly of the same diameter, were as leak-proof as those in the average case. It would be unwise, however, to fail to provide for external drainage from the subhepatic space of Morrison, since in all of these cases there is a certain amount of serous weeping due to the separation of so much scar tissue.

Three of our patients have had one or two mild transient episodes of pain, jaundice, chills and fever. These have quickly cleared and they are, on the whole, a more satisfactory group than any we have observed save those who could be subjected to an accurate end-to-end anastomosis. The longest period of observation is two years. In spite of the small number of cases and the short follow-up period, we believe that this method will be more likely to succeed in properly selected cases than any previously advocated. Although occasion has not arisen in our experience necessitating the establishment of continuity between the separated right and left hepatic ducts and the intestine, we believe that this method could be adapted under these circumstances by using two tubes instead of one.

This general principle of anastomosis of the bile duct to the end of the duodenum or the jejunum is becoming the most popular method in the one-stage Whipple¹⁸ operation for carcinoma of the head of the pancreas. When the gallbladder is used for anastomosis and the common bile duct tied, failure may result because the end of the duct often will not remain closed. Cattell¹⁹ logically advises inversion of the cut-end of the duct as one would do in the gastro-intestinal tract when a two-stage procedure makes cholecyst-jejunostomy a justifiable first-stage operation.

Since recurring attacks of cholangitis are prone to take place if permanent lateral anastomosis between the gallbladder and gastro-intestinal tract are made, I prefer as a first stage the following method: The gallbladder is

RECONSTRUCTION OF BILE DUCTS

drained externally by a rubber tube brought out through a right lateral stab wound. A jejunostomy is established 50 cm. from the ligament of Treitz with a No. 16 French whistle-tip catheter by a purse-string technic and brought out through a left-sided stab wound.²⁰ By elevating the cholecystostomy tube to a suitable level, after ascertaining the approximate intraductal pressure, one may decompress the liver more gradually. The bile is returned to the intestinal tract through the jejunostomy tube. At first this is done by a gravity bottle and later by a glass connection between the two tubes. This allows the second stage to proceed with less handicaps than encountered following any of the first stage procedures I have so far used. One may need to dismantle the jejunostomy at the second stage, which does not complicate the operation materially. The chief advantage is the ability to carry out the second stage after liver decompression in much the same manner as the universally preferred one-stage procedure.

SUMMARY AND CONCLUSIONS

Injuries to the common and hepatic ducts occur with greater frequency than is usually admitted. Many of these technical errors are unrecognized as the cause of death. Survivors are often doomed to repeated operations and a shortened life of invalidism.

No effort should be spared to teach a greater respect for the gallbladder region. Accurate identification of structures to be divided is imperative.

Early recognition of an injured bile duct is essential. Bile peritonitis is not difficult to diagnose and if treated promptly will save life or at least a dangerously prolonged postoperative course. This feature alone has made it difficult for many surgeons of vast experience to close the abdomen without drainage after operations upon the biliary system.

Prolonged external biliary fistula as well as prolonged partial or total biliary obstruction produces a life of invalidism.

Victims of partial continuous jaundice, with repeated flares of cholangitis, should not be denied further attempts for improvement by surgery. They should not be considered as invalidated on the basis of unremediable biliary cirrhosis. Marked improvement and apparent complete recovery from liver damage can be brought about by providing for free flow of bile into the intestine.

Repair of the common bile duct by direct end-to-end suture is the method of choice, when feasible.

Conditions that have destroyed sufficient distal duct to make end-to-end suture impractical are most satisfactorily managed, at this time, by us by anastomosis of the remaining proximal duct to the end of the jejunum as outlined in this preliminary report.

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PRIMARY CARCINOMA OF THE GALLBLADDER*

AN ADDITIONAL REASON FOR EARLY REMOVAL OF THE CALCULOUS GALLBLADDER

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IN MANY WAYS it seems hardly worth while to offer a paper on such a surgically hopeless condition as carcinoma of the gallbladder. On the other hand, and paradoxically, that is the very reason we have the temerity to do so. Because it has such a bad prognosis once it has become established, is there anything that we can or should do to prevent its occurrence? We believe that the situation might definitely be helped in two ways. First, by stressing the fact that primary carcinoma of the gallbladder is much more common than most doctors, particularly the general practitioners, realize; and secondly, that, in a very large majority of instances, it develops as a relatively late sequela to a long-standing chronic cholecystitis and cholelithiasis. Any solution to the problem, then, would seem to lie in the realm of education; education of the doctor, from his medical school days on, in the many dangers of chronic gallbladder disease and gallstones even though *apparently* symptomless, of which the possibility of malignant degeneration is only one; and education of the public that there is only one treatment for gallbladder disease and gallstones, when their existence is proved, and that is operative removal, and the sooner the better. Most of you here hold teaching positions in some medical school. We would indeed be presumptuous to imply that we should teach you, but we do bespeak your aid in teaching others; we feel that all too frequently too little emphasis is given to the importance of operative treatment of the so-called "symptomless gallbladder" or "quiescent gallstone" until far-reaching systemic damage has been done, which is irreparable, then, by late operation. There has been a tremendous amount of discussion in recent years of the complicated operative technic for the treatment of carcinoma of the ampulla and head of the pancreas, but comparatively little has been said about the much less spectacular cholecystectomy to *prevent* the equally common primary carcinoma of the gallbladder, as well as a train of other concomitant and ultimately fatal systemic complications.

The senior author of this paper has had forcibly impressed on him the fact that carcinoma of the gallbladder is more common than is usually represented by having had among his personal cases in the ten years from 1932 to 1941, 11 patients with this affliction. It is one thing, statistically, to analyze this disease and another to observe the decline and sufferings of a fellow human being, realizing that perhaps this could have been prevented.

With this in mind we wish to reiterate the points made by numerous

* Read before the Fifty-sixth Annual Session, Southern Surgical Association, December 5-7, 1944, Hot Springs, Va.

authors in recent years, that cholelithiasis is a potentially dangerous condition and that "silent stones" is a deceiving term. Among the medical profession in general there seems to be a curious reluctance regarding surgical therapy of cholelithiasis and chronic cholecystitis, until the patient himself precipitates the decision by an acute episode which does not subside under treatment with ice-caps, antispasmodics, and opiates. Every surgeon is familiar with the attitude of many a family physician or internist towards his wards as he watches them through subacute attacks of gallbladder trouble or allays the fears of the patient when gallstones are found roentgenologically or during some unrelated operative procedure. This is a most unfortunate circumstance for each such man will not observe many cases of malignancy in his own experience and thus will tend to discount his occasional patient who has a carcinoma of the gallbladder. It is the abdominal surgeon who sees most of these cases and it should be a moral obligation of his to know the facts and to urge early operation.

There are other excellent reasons that call for early operation, the most fundamental of which may be summed up in a statement of Lahey:¹ "It is definitely my conviction that if patients were submitted to cholecystectomy before they had been through repeated attacks of gallstone colic, not only would the end-results be infinitely better but mortality markedly lower.—Not only will early operation for gallstone be associated with a low mortality rate, but it will definitely preserve function and normal conditions in the biliary tract."

We stress also the occasional reference in the literature² to the eventual production of myocardial weakness by chronic gallbladder disease. This sequence has often been called to our attention by clinicians of wide experience. That this is no idle statement is illustrated by the fact that in the causes of hospital deaths in the 1940 series of biliary tract surgery at the Mayo Clinic, cardiovascular disease ranks first, having caused 32.1 per cent of the total mortality.³ This is a tangible factor which should affect one's decision in favor of early operation. Recent observations have also shown striking correlation between gallbladder disease and coronary artery disease,⁴ though it must be mentioned that this may be due to a basic underlying metabolic factor, as may be the case in myocardial disease.

There are other conditions which will not be elaborated upon, but which have been noted and recorded, from time to time, as resulting from calculus and infected gallbladders, such as functional gastro-intestinal symptoms, intestinal obstructions due to gallstones, arthritis, asthma, *etc.*, all with a more than presumptive cause and effect basis. Indeed, the silent gallstone is a very questionable entity.

STATISTICAL SURVEY

Admittedly, surgical statistics regarding the occurrence of carcinoma of the gallbladder are misleading. Autopsy findings are more reliable, generally speaking. Mohardt,⁵ in a recent collective review, and Kirshbaum and

CARCINOMA OF GALLBLADDER

Kozoll⁶ have presented large series showing that the general incidence of gallbladder carcinoma is from one-quarter to three-quarters of 1 per cent of all autopsies, or about 5 per cent of the total of all cancer disclosed at autopsy. Eight to 10 per cent of all cancer occurring in the female is primary in the gallbladder, as compared to the male incidence of 1 to 4 per cent. This discrepancy is not so striking, however, when one recalls that the occurrence of gallstones in women over 50 is about 14 per cent, but only 6 per cent in men, maintaining approximately the same sex ratio.

Primary cancer of the gallbladder is very rare in the young, there being only a few cases reported in the literature under 30 years, the youngest 22 years of age. The majority are between 60 and 70 years of age.

About 75 to 80 per cent of all carcinomatous gallbladders are found at autopsy to have coexisting cholelithiasis. Surgical pathologic reports may well show less than this, for, as we have found, inoperable malignancies cannot be satisfactorily explored for stones at the operating table. It may also be noted that in carcinoma of the biliary tract, exclusive of the gallbladder, about one-third of the cases are associated with stones.

This brings us to the fact that, statistically, we are shown that between 4 and 5 per cent of all calculous gallbladders may eventually be associated with malignancy of that organ.

Now, what kind of mortality rate do we have in prophylactic removal of symptomless gallbladders? That is difficult to determine for mortality rates presented in the literature for cholecystectomy include mostly patients in whom symptoms have demanded operation. Graham⁷ gives a rate of 1.5 per cent; the Mayo Clinic, in the 1940 report,³ for cholecystectomy performed for a chronic cholecystitis with stones gives a 1.6 per cent of hospital deaths. Of this last group, 7 per cent were jaundiced. Thus, we see that on a purely statistical basis, regarding the possibility of malignancy as the only reason for advising cholecystectomy, we are entirely justified in our stand, by a mortality expectancy of 1.5 to 2 per cent as against a malignancy expectancy of 4 to 5 per cent.

TABLE I
PATIENT'S AGE AT TIME OF DIAGNOSIS

40-49 years.....	1
50-59 years.....	3
60-69 years.....	6
70-79 years.....	7
80-89 years.....	1

Average age 67.4 years.

Of the 18 cases which we are reporting in our series, two were males, 16 were females. As to age, one was in the 40's, three in the 50's, six in the 60's, seven in the 70's, and one in the 80's. The average age was approximately 67.4 years. The presence of stones was proved in 11 cases; in seven it was impossible to say, due to the extent of the growth. In 13 cases there was a history at least suggestive of gallstones for from one to over 20 years preceding the operation. In four other cases, giving symp-

toms of less than one year's duration, in every instance the complaint seemed based on already inoperable growth. In one case the history was so indefinite as to preclude any estimate of the duration of disease. In two cases there had been previous operations for the removal of stones, with drainage of the gallbladder, one, 20 years, and the other five years before the operation at which the malignancy was found. In each of these, the growth not only involved the gallbladder and adjacent liver, but also proceeded up the old drain tract into the abdominal wall. In both

TABLE II
DURATION OF SYMPTOMS SUGGESTIVE OF GALLBLADDER DISEASE

20 years or over.....	2
10-20 years.....	2
5-10 years.....	5
1-5 years.....	4
Less than 1 year.....	4
History too indefinite to determine..	1

TABLE III
SURVIVAL AFTER OPERATION DETERMINING DIAGNOSIS

Less than 1 month.....	6
1-3 months.....	3
4-6 months.....	4
7-12 months.....	2
13-18 months.....	2
Over 2 years (25 months).....	1
Less than 6 months—13.	Less than 1 year—15.

TABLE IV
PATHOLOGIC REPORT—TYPE OF GROWTH

Adenocarcinoma, primary in gallbladder.....	6
Squamous cell carcinoma.....	3
Carcinoma of gallbladder, primary, unspecified.....	7
Unsatisfactory biopsy.....	2

of these cases there had also been reformation of stones. Six cases survived the operation less than one month, three survived from one to three months, four from four to six months, two from seven to 12 months, two from 13 to 18 months, and one for 25 months. In three cases the gallbladder was removed. In one of these the presence of growth, in addition to stones, was suspected, but no evidence of extension beyond the limits of the gallbladder was demonstrable. This case survived 10.5 months. In the other two cases, very early carcinoma was found on microscopic examination, but was not suspected at the time of operation. One of these cases lived 16.5 months, the other 25 months, but *both died of a recurrence of the malignancy*. From this it would seem that our ability to cure already established primary carcinoma of the gallbladder by operative removal of that organ is very questionable. In a total of 1192 gallbladder operations during this ten-year period there were 18 pathologically proven cases of primary carcinoma of the gallbladder, or slightly over 1.5 per cent. This total included both calculous and noncalculous gallbladders. The percentage of cases showing primary carcinoma is considerably smaller than some other published series, but is still less than the mortality rate for this same series, which was 1.26 per cent exclusive of the carcinomas.

CARCINOMA OF GALLBLADDER

TABLE V
COMPOSITE TABLE OF ALL CASES

Patient	Sex	Age	Stones	Operation	Duration after Operation	Duration of Symptoms before Operation
M. B.	F	78	+	Inop.*	Autopsy	Pain R. U. Q., back and shoulder for 4 years.
M. W.	M	74	?	Inop.	4 mos.	Jaundice for 6 weeks.
A. L.	F	61	?	Inop.	7 mos.	Nausea, gaseous distention, R. U. Q. discomfort for 5 years.
F. B.	F	67	+	Cholecystectomy	25 mos.	"Gallbladder trouble" dating to first acute attack 20 years before.
C. W.	F	87	+	Inop.	3 days	History too vague and indefinite to estimate.
J. D. L.	F	62	+	Cholecystectomy	16.5 mos.	Acute episodes for 9 years.
E. M.	F	57	?	Inop.	5.5 mos.	Attacks of gas and R. U. Q. discomfort about 15 years.
A. W.	M	73	+	Inop.	3 mos.	Gallbladder drained and stones removed 5 years previously, elsewhere.
W. F.	F	62	?	Inop.	9 mos.	Gas and pain in R. U. Q. for about 1 year.
E. T.	F	79	+	Inop.	2 mos.	Gallbladder drained and stones removed 20 years previously, elsewhere.
A. J.	F	56	+	Cholecystectomy	10.5 mos.	Gas, indigestion, R. U. Q. discomfort for about 6 years.
J. G.	F	76	+	Inop.	18 days	Attacks of R. U. Q. pain for over 2 years.
E. C.	F	74	?	Inop.	12 days (pulm. emb.)	Burning discomfort in "stomach" for "several years." Rapid progression, 8 mos.
A. K.	F	72	?	Inop.	2 mos.	Attacks R. U. Q. pain for 5 to 6 years.
R. A.	F	69	?	Inop.	20 days	Pain through upper abdomen for 5 mos.
D. C.	F	47	+	Inop.	26 days (pulm. emb.)	Loss of weight 1 year. Pain in back 3 mos.
E. B.	F	59	+	Inop.	4 mos.	Anorexia and loss of weight, 3 mos. Pain, 2 weeks.
E. K.	F	61	+	Inop.	15 mos.	Pain in upper abdomen, 3 to 4 mos.

* "Inop." means autopsy, or exploration with biopsy of growth.

DISCUSSION.—From our brief series several points can be emphasized. In nearly every case the symptoms presented were due to inoperable growth, with or without preëxisting symptoms of cholelithiasis. The only two cases of early carcinoma were operated upon for long-standing complaints due to the stones contained within the gallbladders, and the finding of malignancy was entirely accidental and unexpected. In spite of this, and removal of the gallbladder, both of these cases died—one in 17 months, the other in 25 months—of recurrence of the malignancy. Therefore, the result of surgery once malignancy is established is most discouraging and makes us reiterate the fact that the only hope that many of these deaths can be prevented is by early removal of simple calculous gallbladders. There are two cases included in our table which are of a group in which malignancy arose in gallbladders which had previously been drained and the stones removed. The new growth in this type of case often presents itself along the old drainage tract as it did in both of these instances. This brings up the point, that the mere removal of stones does not satisfy the moral obligation of the surgeon; removal of the gallbladder is necessary where possible.

Histopathologically, adenocarcinoma predominates; squamous cell carcinoma, usually anaplastic, is less common. Scirrhus growths are frequent; and the colloid type, with peritoneal extensions, are occasional.

In reading most reports concerning carcinoma of the gallbladder from

the surgical point of view, we have found a great deal of superfluous material, specifically in evaluation of the symptoms presented, and the laboratory findings. A simple understanding of the anatomy and pathology involved will be of most help to the clinician. Most new growths originate in either the neck or fundus of the organ. Extension is by local infiltration of the gallbladder wall, then into the liver and adjacent tissues and by lymphatics to the cystic nodes, then to the nodes about the common duct.

Distant metastases are rare, but may occur. The liver is usually already involved at operation.

Thus, we see that obstruction of any point of the biliary tract may occur or there may be only local extension or peritoneal implants. Due to obstruction of the cystic duct, either by stone or growth, empyema and hydrops may occur in conjunction with the malignancy.

With this simple basis of knowledge of the origin and manner of spread of carcinoma of the gallbladder in mind, it is easy to see why there is no syndrome that will make an early diagnosis possible. We have diagnosed this condition preoperatively and diagnosed patients dying without operation, but the diagnosis was based on symptoms arising as a rule from the extensive spread of the disease and other evidence of carcinomatosis. Early malignancies are found by accident, the symptoms indicating operation being due to the coexisting cholelithiasis. It is the occasional case of early carcinoma that makes us feel most futile in treatment as even here the outlook is bad because of the early spread.

CONCLUSIONS

1. Carcinoma of the gallbladder is more common than is generally supposed.
2. Cholelithiasis must be accepted as an etiologic factor because of its frequent association with malignancy.
3. Preoperative diagnosis of carcinoma of the gallbladder is difficult and treatment is rarely of value.
4. With present day surgical methods, prophylactic removal of symptomless calculous gallbladders is entirely justified in most individuals.
5. Valid reasons other than the possibility of malignancy are presented in support of an early cholecystectomy of calculous gallbladders.
6. A series of cases of carcinoma of the gallbladder seen in the years 1932-1941 at the Union Memorial Hospital is presented.

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DISCUSSION.—DR. J. SHELTON HORSLEY, Richmond, Va.: There have been many methods of attempts to reconstruct the common bile duct. One of the earliest was by Sullivan, who, in 1900, described an operation in which a rubber tube or catheter was fastened to the stump of the hepatic or the remaining end of the common duct, carried into the duodenum, and covered with neighboring tissue and omentum.

In 1918, I published a paper on reconstruction of the common bile duct in which the experimental work was carried out in dogs. A segment of vein was turned inside out and sutured into the defect made by resecting a portion of the common duct. The operation was technically successful but biologically a failure. After a few months the tissues of the vein, being unaccustomed to irritation by bile, contracted and formed a complete obstruction. It was then seen that it was necessary not only to have a primary mechanical union but to make a permanent channel; tissue accustomed to its environment must be used. The vein was accustomed to blood, not bile.

On August 13, 1921, I operated upon a patient, Mr. R. B. D., white, age 39, who had been operated upon elsewhere; the gallbladder had been removed at one operation and later the common duct was opened for stones. The patient had a recurrence; and I united the common duct, which was greatly dilated, to the duodenum. He was relieved for a while, but about two years later he had more discomfort and pain, and a roentgenogram, taken on May 27, 1924, showed that some of the barium meal entered the common duct and the hepatic ducts. (slide) Obviously, the common and hepatic ducts would be filled with the duodenal contents from the normal pressure there, and regurgitation into the biliary system occurred. On December 31, 1924, three years and four months after the operation I performed, he was operated upon elsewhere. Many adhesions and liver abscesses were found and the patient died five days after this operation. This would seem to show that any communication between the common duct and the duodenum, with its great peristaltic activity, and receiving gastric material under strong pressure from the stomach, would be unwise, as it almost certainly would be followed by cholangitis.

In October, 1943, Lt. Col Guy Horsley and I published a method of choledochenterostomy* in which a loop of jejunum about two or three feet from its origin was united to the common duct by a rubber band and an entero-enterostomy was made between the limbs of the loop by rubber bands to bypass the choledochenterostomy and so avoid the pressure that would force the intestinal contents into the biliary tracts. (slides) I have used this technic clinically, as mentioned in this paper, and have had successful cases since this paper was published.

* Cholecysto-enterostomy, Choledochenterostomy and Entero-enterostomy by Means of Rubber Bands: The Use of Rubber Bands in the Mikulicz Operation. *ANNALS OF SURGERY*, **118**, No. 4, 558, October, 1943.

DR. THOMAS J. ANGLE, Boston, Mass.: The ideal procedure for the surgical repair of a stricture of the common bile duct is one which permits bile to flow readily through the previously injured portion of the duct, and then to pass through a normally functioning sphincter of Oddi into the duodenum. We had thought that the implantation of a vitallium tube into the common duct would approximate this ideal. Continuing experience with vitallium tubes, however, has taught us that this method, like all others we have tried, has definite disadvantages and limitations.

Dr. Howard Clute and I have had 10 patients in whom 12 vitallium tubes for common duct strictures have been used. For this discussion these may be divided into (1) those in which the common duct above and below the stricture could be utilized in the repair; (2) those in which the distal end of the duct could not be so used, and; (3) stricture or narrowing of the duct from chronic pancreatitis.

Seven of our patients had common duct strictures so situated that a vitallium tube could be inserted in such a way as to reestablish the continuity of the duct and to retain the function of the sphincter of Oddi. The first of these patients, operated upon in November, 1940, was reported before this Association by Dr. Clute. She has remained well since (four years) except for one attack of pain and fleeting jaundice. Three others of this group have gone from six to 18 months without trouble. The remaining three, however, have had repeated attacks of pain, fever, chills and jaundice; two have had a second attempt at repair of the stricture by vitallium tubes—one with slightly better success and one a failure. The third has gone two and one-half years since operation for a completely obstructing stricture, but is now having attacks of pain, jaundice, etc.

In brief, then, of the seven patients in whom we believed vitallium tubes would be helpful, four are doing well after intervals of from six months to four years, two are still having attacks of pain and jaundice, and one has been a complete failure.

In two cases, in spite of retrograde catheterization through the duodenum, we were unable to find sufficient distal common duct to utilize in the repair. In each case we anastomosed the common hepatic duct to the duodenum over a trumpet-shaped vitallium tube placed between the common hepatic duct and the bowel. The first patient passed the tube per bowel; she has gone two years with only occasional attacks of cholangitis. In the second patient the tube remained *in situ* and all went well for three months. She then returned to the hospital because of severe gastro-intestinal bleeding; this was fatal in spite of heroic measures to control the hemorrhage. At autopsy it was found that the distal end of the vitallium tube pressing on the posterior wall of the duodenum had caused an ulcer that bled. From these two experiences we do not recommend vitallium tubes as splints to be used at the site of a choledochoduodenostomy.

In our series the last case was one of obstructive jaundice, apparently due to pressure on the common duct from a severe chronic pancreatitis. Here a very long vitallium tube was placed in the duct. He has remained well for eight months.

The use of the vitallium tubes for the repair of common duct strictures, therefore, in our hands has given us perhaps 50 per cent good results when both ends of the duct were present. They have not been helpful in choledochoduodenal anastomoses. One case with chronic pancreatitis has apparently been helped. We are concerned with the problem of why some tubes may remain in the duct for years without trouble, and others cause difficulty in a few weeks. It may well be that with Dr. Allen's ingenious new method many of our problems will disappear. Certainly our experiences with vitallium tubes leave us ready for a better method of dealing with common duct strictures.

DR. FRANK H. LAHEY, Boston, Mass.: This is a very ingenious operation and it will be a helpful addition to the number of methods that we now employ. I would like particularly to make a plea about this question of strictures of the bile ducts. Strictures should be treated primarily by the surgeons who are doing gallbladder operations; that is, they should be treated in a preventive way. About two months ago I sent an article to one of the surgical journals advocating an approach to this problem that may not be entirely accepted without some criticism.

I suggested first of all that better anesthesia, wider incisions and better exposures would prevent many of these strictures because these precautions would prevent injuries to the ducts. Because we now have repaired 130 strictures of the common duct in patients who have been sent to us, in many cases with great difficulty, my suggestion in the editorial

CARCINOMA OF GALLBLADDER

was that if a man injures a duct he should assess his experience very critically as to whether or not he has the skill to repair it, because in the repair of injuries to the hepatic and common ducts if the remaining ducts are again injured and so used up, another repair has less chance of being successful. One of the things we have learned is that each repair that is attempted on one of these injured ducts uses up hepatic duct until it finally disappears into the substance of the liver and so makes subsequent repairs additionally difficult and uncertain of success.

One could, of course, be accused of being selfish in stating this, but you have just heard, in this paper and the discussions, three men from Boston, each representing different institutions, on this matter of strictures, and there are many other men throughout the country who have had experience with strictures, so that I feel free to make these suggestions.

Our very best results in repair of strictures of the common and hepatic ducts have been in those patients who have been sent to us after the injury, and not too long afterward, because then there is enough of the duct structures left so that a reasonable reconstruction operation is possible.

There are several things one has to learn about strictures of the common and hepatic ducts. One is that it is possible, with the fulguration apparatus and with careful dissection, to dissect a considerable length of hepatic duct out of the hilum of the liver. One also has to learn to be reasonably immunized to opening the portal vein. I have personally opened it and sutured it six times. It is a little hair-raising, but on the other hand, the pressure in the portal vein is low and with one finger in the foramen of Winslow, pressure on the vein will control it. We have successfully sutured the vein in all these cases.

In the beginning of our experience we put in some rubber tubes instead of vitallium tubes in cases of stricture of the duct because vitallium was then not available. A few of these have worked well, but we have now replaced most of them with vitallium tubes. I do not know whether or not vitallium tubes will clog as many of the rubber tubes have, but so far it seems likely that there will be less deposit of bile salts upon them, and up to the present time they have certainly been more successful than the rubber tubes.

I do not think we should give up reconstruction of the duct by the use of the vitallium tube. I by no means feel discouraged about it. Most of the strictures are reasonably high in the hepatic duct, which leaves the sphincter of Oddi intact. I much prefer a reconstruction of the bile duct with the sphincter intact than any implantation of the cut end of the duct into the intestine or implantation of the intestine into the hilum of the liver because of the danger and frequency of ascending infections when no sphincter is present.

We have learned that one of the easiest ways to find strictures of the common duct is to turn the duodenum over, find the point of entrance of the common duct into the duodenum, follow it up through the split head of the pancreas and insert a probe upward. This will usually take one straight up to the point of stricture from which the entrance to the intrahepatic portion of the hepatic duct can be found and opened.

No one can as yet say what the ultimate results will be with vitallium tubes, but when one realizes that these cases otherwise are hopeless, I am by no means sure that they will not help us in a most difficult situation.

It may be of interest to report that a golf professional in whom we put a vitallium tube a year and a half ago is now touring the winter golf tournaments, and has finished in several of them in top-flight positions.

DR. ROBERT S. DINSMORE, Cleveland, Ohio: I was much interested in what Doctor Allen said about the insidiousness of the symptoms of localized bile peritonitis. I have seen patients on the seventh or ninth day following operation, without symptoms or temperature rise when we see them in the morning, and within a few hours there is a high temperature and high pulse rate. We recognize that something is wrong, open the abdomen and find a huge collection of old bile. Apparently they are able to tolerate this for some time without symptoms, not even with the uncomfortable feeling Doctor Allen described.

I have been interested in how to find that stump and would like to ask: do you go to the left side or follow the liver border down? Lord Moynihan once searched for

the stump for a long time, and finally said, after two hours: "From now on I am on my own time; anything under two hours I consider the patient's!"

DR. HARVEY B. STONE, Baltimore, Md.: I want to say a word of commendation for the splendid paper of Doctor Finney—splendid in presentation and in the ideas it contains. I would like also to say this: At least in the community where Doctor Finney and I work, there is still a very widespread feeling among the general profession, and to a certain extent among surgeons, that there is no particular reason to be anxious about the so-called silent gallstones. He brought out many points of interest, but I think the one he emphasized particularly was that the presence of silent gallstones for many reasons should not be considered an innocuous condition, among those reasons being the close correlation between the origin of malignancy and the presence of gallstones. So I think he has given us another cogent reason why we should regard a gallbladder containing stones a menace to the patient's health, irrespective of whether or not he is suffering from it.

DR. JOHN J. MORTON, Rochester, N. Y.: I am sure Doctor Herman Pearce would appreciate it if anyone who has had results with the use of vitallium tubes would let him know. He is especially interested in this and attempted to review it last fall. He reported his results at the Connecticut State Medical Meeting in the fall and if I remember his figures, 80 per cent of his cases were doing very well, and there were very few reports from outside of unsatisfactory results. So I am sure he would be interested in hearing about the bad results. In his hands the results have been satisfactory, especially in those cases where there are large segments of the common duct missing.

I am glad that Doctor Allen has made this contribution, which is anatomic and gives an opportunity to use normal structures. I do not believe that turning the jejunum around will prevent ascending infection. In cases of resection of the pancreas for carcinoma, where a similar anastomosis has been used, we have seen hepatitis at post-mortem examination. This is an ever present danger when the bowel is anastomosed to the liver bile ducts or gallbladder.

DR. ARTHUR W. ALLEN, Boston, Mass. (closing): Most of the queries raised by the discussors are considered in the body of the paper. Therefore, I will not repeat the reasons why I think the tube should be a temporary one and should be removable, nor why I think a rigid tube of metal not so good as one made from the patient's own tissues.

I expect that we will get less cholangitis in this low implantation of the proximal jejunum than we do in the high implantation of the stomach into the jejunum following the Whipple operation. This may not eventually prove to be true, but it now appears that these patients upon whom I have performed these operations are having less evidence of ascending infection than others have had following resection of the head of the pancreas.

Doctor Dinsmore has asked two difficult questions and I doubt if I can answer them satisfactorily. I believe that the patient who does well for seven or eight days following cholecystectomy, and then suddenly over a period of 12 hours becomes very ill with obvious peritonitis, may be explained on the basis that the ligature on the cystic duct has cut through, allowing bile to drain into the peritoneal cavity from this source. Theoretically, one should invert the cystic duct as one does the intestine when a tight closure is expected. This is not usually practical, due to its small caliber. One may have less tendency for lack of proper healing of the duct if it is crushed with a clamp before the ligature is applied. A transfixion suture distal to the ligature may prevent the tie from slipping off the duct.

The only rule I have for finding the stump of the bile duct is to follow the under surface of the liver, which I believe should be freed entirely on the right and left sides of the liver sulcus. After this is done, one usually comes down onto the portal structures which can be identified by the pulsation of the hepatic artery. Aspiration of the likely area where the duct is expected with a fine hypodermic needle, as suggested years ago by Dr. Donald Balfour, is a very useful procedure. I think it is fair to say that one should be able to expose the duct within a two hour period. Many of them are easier than others, depending on the grade and type and vascularity of the adhesions. One should not try to operate against time when doing this type of operation.

A NONSUTURE METHOD OF BLOOD VESSEL ANASTOMOSIS*

REVIEW OF EXPERIMENTAL STUDY REPORT OF CLINICAL CASES

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WE BEGAN AN INVESTIGATION in the early spring of 1942, seeking an efficient method of blood vessel anastomosis adaptable to war use. An early start seemed timely because it would permit an opportunity for the indoctrination of those few basic principles of blood vessel surgery so necessary to the success of any method of blood vessel anastomosis, however simple it be in technical execution.

We entered this war equipped with important adjuncts in the salvage of wounded extremities with main artery damage. The early and effective treatment for shock, the control of infection and vasospasm are known to promote the maximum blood carrying capacity of undamaged collateral blood vessels. It would be reasonable to expect, then, in this war, that extremities would survive or become gangrenous following ligation of damaged main arteries in direct accordance with the number of collateral vessels remaining anatomically intact.

It has long been known that war missiles causing damage to main arteries cause concomitant damage to collateral vessels, severe or slight, in accordance with the type of acting missile. Our first real experience with high explosive warfare was in World War I. We are informed that the shrapnel of World War I fame caused wounds characteristically destructive of collateral vessels.^{1,2} A great expansion in design of high explosive missiles in the form of land mines, grenades, fragmentation shells, aerial bombs, rocket shells, *etc.*, made it seem likely there would be a preponderance of wounds highly destructive of collateral blood vessels in this war. In view of these prospects and the fact that there is an anatomic limit to the number of collateral blood vessels that can be destroyed and yet have a limb survive ligation of the damaged main artery, the desirability of gaining control of blood flow by anastomosis in this war was early emphasized.

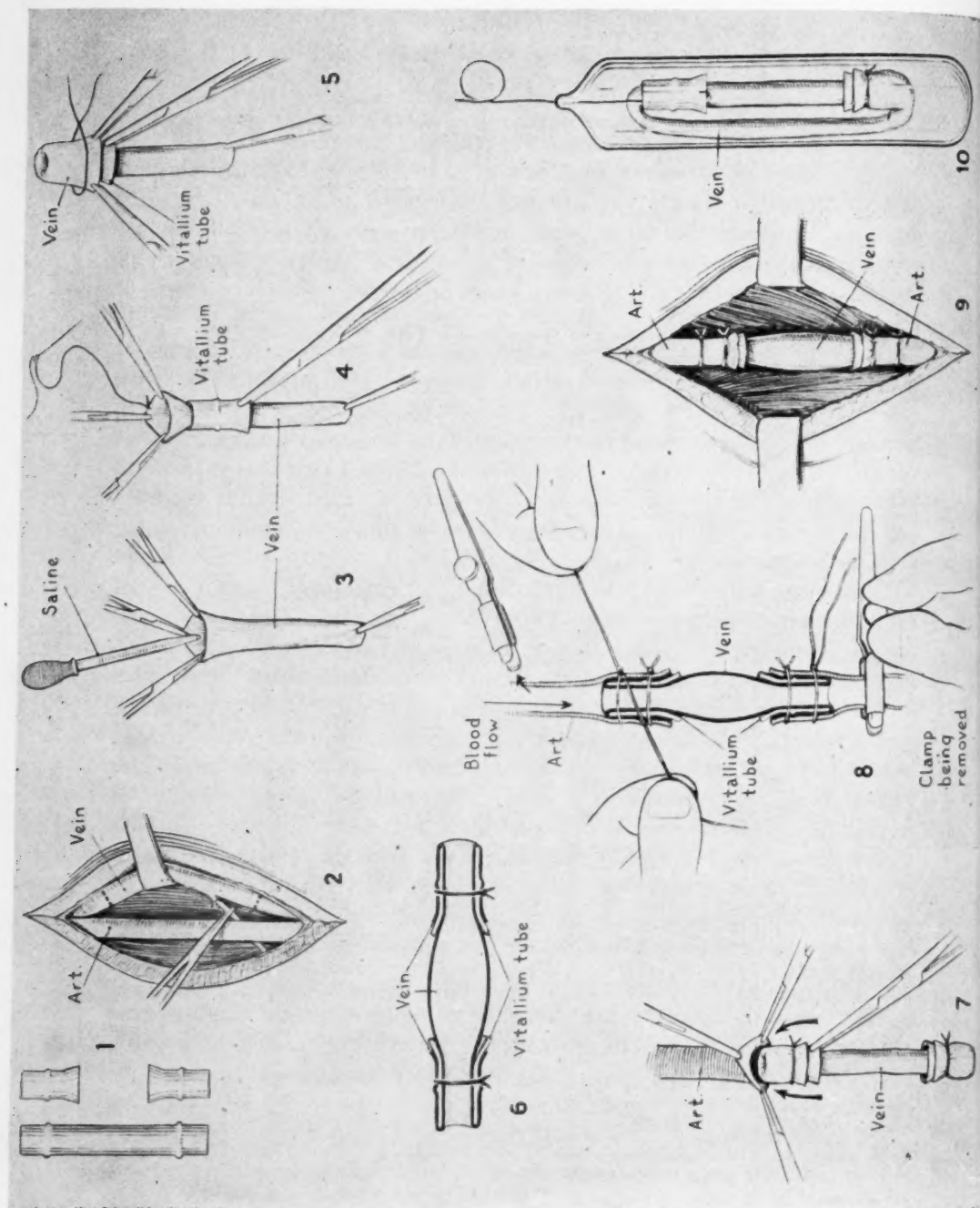
A NONSUTURE METHOD OF BLOOD VESSEL ANASTOMOSIS³

Starting with the ancient method of restoring blood flow through severed arteries, of which there is none simpler than tying the cut ends of a vessel over the ends of a connecting cannula, we added the principle of lining the cannula with a vein graft.

We selected vitallium, an alloy,* because of its nonirritating qualities, as

* Approximate composition is cobalt 65 per cent, chromium 30 per cent, molybdenum 5 per cent. The cannulae and tubes were supplied by the Austenal Laboratories, Inc., of Chicago and New York.

*Read before the Fifty-sixth Annual Session, Southern Surgical Association, December 5-7, 1944, Hot Springs, Va.



NONSUTURE BLOOD VESSEL ANASTOMOSIS

a suitable material from which to make cannulae or tubes. To facilitate bridging arterial defects of any length we recommend an identical technic employing a vitallium tube on each end of the vein graft.

Figure 1 illustrates the technic. The ends of the vein graft are everted (cuffed) over the ends of the cannula or tubes and secured by fine silk ligatures placed behind tying ridges four or more millimeters from the ends. The cut-ends of the artery are triangulated with mosquito clamps and brought over the vein-covered ends of the cannula or tubes and secured by ligatures of heavy silk placed behind the tying ridges. To prevent blood from passing between the vein and artery intimas, a fine silk ligature is tied, just snug, one or two millimeters from the end.

The method affords a broad vein intima-to-artery intima contact for the formation of a firm junction by healing. Because of the usual widespread bacterial contamination of acute traumatic vascular injuries we compared the efficiency of the nonsuture double vitallium tube technic with the Carrel suture method in vein graft bridging of femoral artery defects in contaminated wounds of dogs. The results in two series of 24-hour-old wounds, using the Carrel suture technic in one and the nonsuture method in the other, were 40 per cent successes with the Carrel suture method, as against 85 per cent successes in the nonsuture series. Débridement and the sulfonamides were used in both series and anticoagulants in neither.

At the suggestion of Dr. Rudolph Matas we investigated the use of heteroplastic vein grafts and methods of preserving them. There is clinical⁴ and experimental⁵ evidence to show that if an anastomosed main artery can be kept patent in a wounded extremity beyond the period of posttraumatic edema up to 14 days, the extremity will be saved. By that time collateral vessels will have developed sufficiently to avoid the occurrence of gangrene.

To gain information on whether heteroplastic veins will function adequately to prevent gangrene when used to bridge arterial defects the following experiments were performed: Figure 2 is a photograph of two dogs in which the right hind leg was amputated, midhigh level. After an interval of 24 hours, the legs were reimplanted, using the nonsuture two-tube technic, and vein grafts from a third and fourth animal to bridge the defects in the femoral artery and vein. The amputated limbs were preserved during the

FIG. 1.—Illustrating the operative technic of the nonsuture method: 1. Cannula and tubes (for use in the single or double tube technics). 2. Illustrates removal of vein graft. Note the branch is tied close to the vein with fine silk before clamping. 3. Irrigation of vein graft with normal saline to which a small amount of heparin may be added if desired. 4. Method of triangulating end of vein with mosquito clamps. 5. Cuffing and securing everted end of vein upon the vitallium tube. 6. Illustrates double tube technic with the vein graft mounted. 7. Introducing the distal end of the vein graft mounted upon a vitallium tube into the proximal end of the artery. 8. Illustrates tying fine silk ligatures, just snug, to prevent blood from penetrating between the vein and artery intimas. Also releasing the proximal rubber-shod clamp first to facilitate the passage distalward of any residual air bubbles within the graft. 9. Completed anastomosis—The perivascular tissues are closed snugly around the anastomosed artery when possible. 10. A convenient way of preserving, hermetically sealed in an ordinary test tube, a vein graft for quick freezing. The graft is moistened with normal saline, one end mounted upon a vitallium tube in the usual manner; the other end is passed through a second tube and brought over the first tube to protect the intima until used. A wire serves to suspend the graft.

24-hour interval in cracked ice. The dogs were given sulfathiazole, one gram twice daily from the time of the first operation. The photographs were made 12 and 21 days, respectively, following reimplantation of the limbs, and there is every evidence of a good supply of arterial blood in these reimplanted limbs. Heteroplastic vein grafts were used to bridge femoral artery defects in ten additional animals. The anastomoses functioned for 27 days (average), which is well beyond the postulated 14 days of posttraumatic edema.



FIG. 2.—Photograph of two dogs, No. 2110 (12 days) and No. 2092 (21 days) postoperatively; in which the right hind leg was amputated at the midthigh level and reimplanted after having been kept in cracked ice for 24 hours. Moderate edema is still present in the 12-day animal.

THE PRESERVATION OF VEINS

We have found that veins quick-frozen in an alcohol dry ice mixture and kept in the frozen state function adequately when used as heteroplastic grafts to bridge arterial defects. The veins may be kept at or below minus 40°C . for indefinite periods. We proved continued patency of the anastomosis in two instances at 38 days, following the use of grafts, preserved nearly three months, to bridge femoral artery defects in dogs. Patency of an anastomosis was demonstrated at 19 days following the use of a quick-frozen segment of human saphenous vein, preserved three weeks, to bridge a defect in a dog's aorta (Fig. 3).

Figure 10 illustrates a convenient way of preserving a vein graft quick-frozen for emergency use. Note that one end of the vein graft is already cuffed on one vitallium tube with the other brought over it to protect the intima. Repeated demonstrations have revealed that with ready-mounted vein grafts at hand, completion of an anastomosis may be routinely accom-

plished within 15 minutes by the average operator. For war use, ready-mounted, quick-frozen, vein grafts serviced to field and evacuation hospitals *via* the blood bank personnel, would afford an important alternate, during large offensive engagements, to the necessity of having to remove grafts at the time.

We present two cases to illustrate the application of the nonsuture method of blood vessel anastomosis in the treatment of acute traumatic extremity wounds with main artery damage:



FIG. 3.—A photograph of a dog's aorta taken 19 days after operation. A defect in the aorta was bridged with a segment of human saphenous vein which had been preserved quick-frozen for three weeks. Note the funneled ends of the two vitallium tubes and the vein graft in between.

Case 1.—No. 714522: M. E. A seven-year-old boy admitted to P. H., July 20, 1943, in shock due to hemorrhage from a severed brachial artery. The boy's left arm had been pushed through a glass door while at play. He received an irregular laceration across the inner aspect of the middle section of the arm. The brachial artery, median and ulnar nerves were severed. The patient was promptly given 500 cc. of blood, 300 cc. of normal saline and 2 grams of sodium sulfadiazine, intravenously.

Operation.—(Five hours after injury) Ether anesthesia: A pneumatic tourniquet was applied well above the wound. The skin was carefully "prepped" and the wound thoroughly irrigated with saline. The retracted ends of the severed brachial artery were freed for a distance of 5 to 6 cm. The tourniquet was released sufficiently to flush out severed vessels. Rubber-shod clamps were quickly applied to the ends of the severed artery and the latter irrigated with saline. The cut ends of the brachial vein were transfixied with "C" Deknatel silk. As débridement proceeded, the smaller vessels were ligated with "B" Deknatel silk.

At this point of the operation the team was divided. This enabled one section to proceed with repair of the nerves, using arterial silk, while the other proceeded with preparation of a vein graft for bridging the arterial defect. Accordingly, the left femoral vein was isolated for a distance of 10 cm. distal to the origin of the profunda. Branches were ligated with "B" Deknatel silk flush with the vein, clamped, cut and ligated distally (Fig. 1). A ligature of No. 1 Deknatel silk was placed on the distal end of the femoral vein. The blood was milked upward and another ligature placed proximalward. The vein was further secured with transfixion ligatures and the intervening segment quickly removed. (The length of a vein segment before removal should be 2 cm. longer than the arterial defect). The vein graft was thoroughly irrigated with

saline. A silk suture on a straight needle passed through the wall of the distal end served to pull the vein through a 2 Mm. vitallium tube and later, when cut short, to identify the distal end of the vein graft. The end of the vein was everted (cuffed) over the vitallium tube and held in place by a ligature of No. 1 Deknatel silk placed behind a tying (holding) ridge (Fig. 1). The other end of the vein graft was mounted, in identical manner, upon a second 2 Mm. vitallium tube. (Care must be taken to avoid a valve at the eversion site to prevent diaphragm occlusion).



FIG. 4.—Arteriogram of the anastomosed brachial artery in Case 1, taken one month after operation. Whereas, the funneled ends of the vitallium tubes are close together, a column of diodrast may be noted passing through the intervening vein graft. Compare the long tubes as used in this case with the shorter tubes of recent design. (See insert)

Next, the severed ends of the artery were débrided and again irrigated to remove clinging particles of fibrin. (Control of blood flow by the rubber-shod clamps placed well away from the ends must be absolute).

The distal end of the severed artery was then triangulated by placing mosquito clamps, taking 1.5 Mm. bites, upon the cut edge. The flange of the vitallium tube carrying the proximal end of the vein graft was grasped with a stout, straight clamp and the graft was dipped in saline. Following this, the vein-covered tube was introduced into the funneled end of the artery and the latter brought well up on the tube. The artery was secured to the tube, intima to intima with the vein, by a No. 3 Deknatel ligature tied tightly behind the holding ridge, using a surgeon's knot (Fig. 1).

NONSUTURE BLOOD VESSEL ANASTOMOSIS

The second vitallium tube, bearing the distal end of the vein graft, was irrigated with saline (using a blunt nose medicine dropper) and quickly introduced into the proximal end of the artery in an identical manner. Finally, ligatures of No. 1 Deknatel silk were placed around the artery, barely snugging the artery to the cuffed vein at a point 1 to 1.5 Mm. from the ends of the vitallium tubes (Fig. 1).

Just before removing the rubber-shod clamps 15 mg. of heparin (1.5 cc. of liquaemin) was injected in the artery just proximal to the anastomosis using an hypodermic needle. The proximal clamp was removed first, followed immediately by removal of the distal rubber-shod clamp. (Should this not serve to force all trapped air bubbles distally from the vein graft, elevation of the limb with gentle milking pressure upon the graft must be resorted to).

A pink color of the boy's hand resulted immediately after reestablishment of blood flow, and only a few minutes elapsed before the left hand was as warm as the right. The muscles, fascia and skin were approximated with fine silk. The patient received 300 cc. of blood during the operation and left the table in excellent condition. The arm was placed in a plaster splint with the hand in volar flexion.

Postoperative Course.—The wound healed per primam. The patient was discharged on the 11th postoperative day in a constant tension splint to permit exercise of unopposed extensor muscles, but protecting the paralyzed flexor muscles of the forearm against overstretching. Sulfadiazine therapy was continued through the fifth postoperative day. We cannot say that postoperative heparinization was adequate (its administration by continuous intravenous drip was discontinued after 60 hours), because the clotting time (capillary method) varied from 3 to 6 minutes. Daily observations of the left radial pulse revealed it unchanged in volume.

Follow-up 1 month: Patient receiving physiotherapy. Left radial pulse remains good. Arteriogram (Fig. 4) confirms the patency of the anastomosis. However, thrombosis of the anastomosis took place immediately following the injection of diodrast.

Follow-up 5 months: Chronaxie studies reveal innervation of the forearm muscles supplied by the median nerve.

Follow-up 14 months: Complete sensory and motor recovery of the median and ulnar nerves. However, there is yet some inability to completely extend the fingers due to weakness of the interossei muscles, though chronaxie studies reveal complete regeneration.

Follow-up 19 months: Complete return of function.

Case 2.—No. 751446: R. J. A 15-year-old colored boy entered the P. H., July 7, 1944, with a severe laceration of his left arm. He incurred the injury falling through a plate glass window. A tourniquet was promptly applied. After his arrival at the hospital, some hours later, a pneumatic tourniquet was applied, and deflated at half hour intervals. Family and past history noncontributory.

Physical Examination: Temperature 101° F., pulse 132, B. P. 160/80. An apprehensive, well-developed male, not in shock. Examination of the left arm revealed a transverse laceration starting in the midbiceps region, directed obliquely downward, dividing all soft parts to the bone, and entering the elbow joints anteriorly. The laceration involved approximately two-thirds of the circumference of the arm. The radial and median nerves were severed as were the brachial artery and accompanying veins. As a result of muscle retraction the wound gaped widely. The forearm and hand remained pale, cold and pulseless following removal of the tourniquet.

Operation.—The operation consisted of irrigation and débridement of the wound; suture of the radial and median nerves. The brachial artery defect was bridged with a segment of saphenous vein, using the nonsuture technique, with a 4 Mm. vitallium tube on each end. Twenty milligrams of heparin (2 cc. of liquaemin) was given intra-arterially upon establishing blood flow through the anastomosis. Five grams of sodium sulfadiazine was given in saline during the operation. Hemostasis was completed and the

muscles fascia and skin were sutured. Silk technic was used throughout. The arm was placed in a posterior molded plaster splint with the elbow at right angles. An excellent radial pulse was felt upon releasing the brachial artery to blood flow.

It was of extreme interest, however, that immediately following complete release of the tourniquet and restoration of flow through the anastomosis, the patient began to go into shock. The B. P. fell from 160/75 to 90/40 within five minutes, and was down to 55/40 during the next 30 minutes in spite of the rapid administration of 500 cc of whole blood. One hundred milligrams of eschatin was given, and the patient recovered slowly from shock. Whereas 200 mg. of heparin in Pitkin's menstruum



FIG. 5.—Arteriogram of Case 2. Taken 34 days after operation. Note the patent saphenous vein graft is about the same size as the anastomosed brachial artery. The slight bulge of the upper end of the graft marks a valve site in the vein graft.

(Loewe method) was given subcutaneously in the lateral aspect of the thigh, it is likely that its action was neutralized in great part by subsequent transfusions of whole blood. Within one hour after the conclusion of the operation the entire arm was greatly swollen and remained so for many days. Edema was so great during the first four days a radial pulse could not be felt. Oscillometric readings, however, indicated patency of the anastomosis. The patient's temperature ranged from 103° to 104° F. the first three days. A prompt fall in temperature followed a shift to penicillin therapy. The wound healed *per primum*. The radial pulse remained excellent and 34 days post-operative an arteriogram confirmed the patency of the anastomosis (Fig. 5).

Follow-up 4 months: Radial pulse remains excellent. Chronaxie studies revealed no innervation of the forearm muscles as yet. Muscles supplied by the tourniquet damaged ulnar respond to direct stimulation, whereas there is no response from those supplied by the sutured radial and median nerves. Furthermore, the latter muscles are more wasted and fibrotic.

Follow-up 7 months: Evidence of beginning nerve regeneration.

DISCUSSION.—The similarity of these wounds to war wounds was as follows: (1) Damage to collateral vessels was extensive because of the location and scope of the wounds. (2) They were contaminated wounds, with delayed treatment: Time elapsed from injury to reestablishment of blood flow by anastomosis was eight hours in both cases.

NONSUTURE BLOOD VESSEL ANASTOMOSIS

By the time the nonsuture method was ready for war use (October, 1943), the incidence of gangrene following ligation of damaged main arteries in the European theater of this war bordered 70 per cent, average for all arteries. The most likely explanation for this is a preponderance of wounds due to high explosive missiles highly destructive of collateral vessels. In view of these facts, restoration of blood flow by anastomosis remained the sole chance for salvage of limbs in this group.

In this war, for the first time in history, control of infection and blood clotting assures the success of blood vessel anastomosis. Murray⁶ first demonstrated in dogs that the efficiency of the Carrel suture anastomosis in clean wounds could be boosted from 35 to 100 per cent by the postoperative administration of heparin by continuous intravenous drip. Credit should go, however, to Loewe, and associates,⁷ for the development of a method of heparinization peculiarly adapted to war use. These investigators have demonstrated that safe, continuous heparinization may be maintained for weeks at a time following the subcutaneous deposit, at 48-hour intervals of heparin in Pitkin's menstruum. The latter permits a more even release of heparin than is practical to attain by the intravenous drip method. Hence, with the standardization of dosage it is now practical to administer safe, automatically controlled, surgical heparinization to cases with extremity wounds at the field hospitals near the battle fronts without the necessity of ascertaining a blood clotting time!

It is a clinical fact that the elimination of devitalized tissue by débridement, the control of infection, and the control of blood flow constitute a basic triad upon which successful salvage of wounded extremities with main artery damage depends. Control of infection and blood clotting in assuring success of the nonsuture method of blood vessel anastomosis in this war completes the important triad, namely, control of blood flow. Restoration of a pulsating normal volume blood flow by anastomosis revitalizes damaged tissues. It is a fact that damaged, anemic tissues afford a peculiarly favorable medium for the development of gas bacilli. Likewise, a diminished blood flow disposes to the development of bone infection, delays bone union, and the healing of wounds in general.

OTHER USES OF THE NONSUTURE METHOD OF ANASTOMOSIS

The development of an efficient method of blood vessel anastomosis, relatively easy of technical accomplishment, naturally, at once, suggested to the authors the various problems to which the method may be applicable clinically. Some of these we will present; some others will be deferred pending the completion of current experiments.

We present a case to illustrate the use of the nonsuture method to restore blood flow in the artery after excision of traumatic arteriovenous fistulae.

Case 3.—No. 754742, J. W. A 24-year-old male, entered P. H., July 25, 1944, complaining of a pulsating swelling of the right thigh of 2.5 years duration. P. H. and

F. H. noncontributory. P. I.: The pulsating tumor became apparent to the patient a few days following a bullet wound. His important disabilities were increased sensitivity of the leg to cold, decreased exercise tolerance both in the leg and general, and exertional dyspnea.

Physical Examination.—The heart percussed large and a systolic murmur was heard over the precordium. B. P. rt. arm 110/40. Examination of the rt. leg revealed a pulsating mass 5 x 3 cm. over Hunter's canal at the junction of the upper and middle thirds. A small scar in the overlying skin marked the entrance of the bullet. A thrill was palpable over the mass and a continuous bruit with systolic accentuation could be

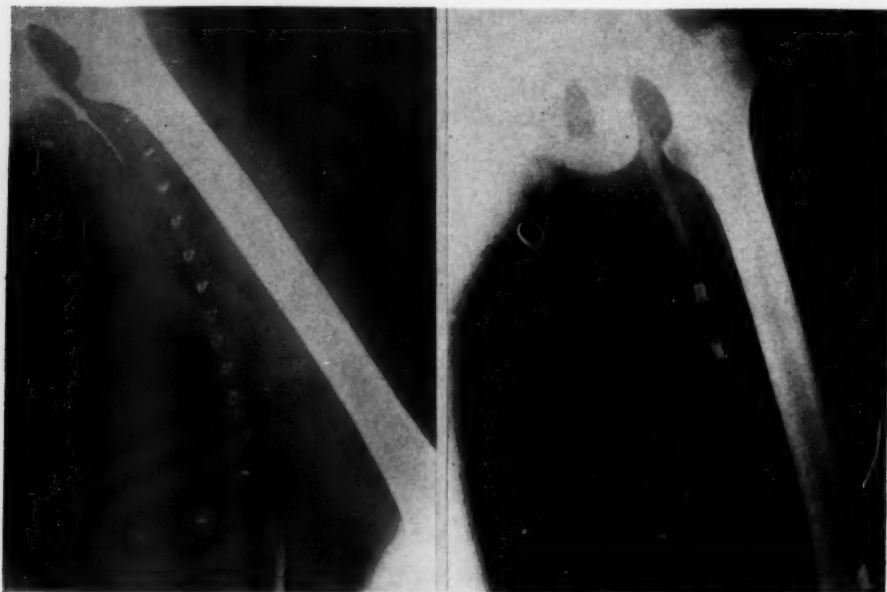


FIG. 6A

FIG. 6B

FIG. 6.—A. & B. Arteriograms of Case 3. A. Shows a diodrast visualization of the arteriovenous fistula of the femoral artery and vein taken before operative excision of the fistula. Note the spasmodic narrowing of the artery proximal to, and its dilatation at, the fistula site. A segment of this hugely dilated vein was used as a graft to bridge the arterial defect following excision of the fistula. B. An arteriogram 14 days after operation demonstrates the patency of the fistula. Note the small size of the intervening vein graft in comparison with A.

heard. Pulsation was faint in the rt. popliteal artery and absent in the distal arteries. Obstruction to blood flow through the fistula caused marked bradycardia. A roentgenogram of the heart revealed an increase in the transverse diameter of the heart, most marked to the left. Hb. 14.8 Gm., R. B. C. 5,910,000.

Operation.—Excision of the A. V. fistula, with vein graft bridging of the arterial defect by the nonsuture method, using a segment of the accompanying femoral vein. The fistula measured approximately 1 cm. in diameter. Pressure closure of the fistula caused an increase (from 4 to 8 Mm.) in the diameter of the distal portion of the femoral artery. Diameter of the artery proximal to the fistula approximated 12 Mm., with some thinning of the vessel wall. Upon release of the rubber-shod clamps and reestablishment of the circulation, the vein graft dilated to 2 cm., but was reduced considerably by closing the perivascular tissue snugly around it. Following the anastomosis there were excellent pulsations in the dorsalis pedis and Posterior Tibial arteries. Two weeks later, arteriography confirmed the patency of the anastomosis (Fig. 6). Blood clotting time was maintained around 55 minutes for eight days following operation, using subcutaneous heparin.

Circulation studies before and after operation, using radioactive isotope sodium were as follows: Circulation time (arm to foot) of the normal (left) leg was 40

NONSUTURE BLOOD VESSEL ANASTOMOSIS

seconds compared to 30 seconds for the right leg after operation. A volume flow to the rt. foot preoperatively was 40 per cent below the normal left foot. whereas postoperatively the volume flow to the rt. foot was increased to 20 per cent above the normal left leg. The above studies were carried out at rest.

Follow-up.—Four months postoperative, slight swelling of leg upon standing for long periods which disappears quickly upon exercise. Foot on operated leg feels warmer than left foot. Plays tennis and goes deer hunting. The latter involves walking up and down mountains often as much as ten miles a day. Examination: Rt. foot warmer than left. Pulsation felt over anastomosis, popliteal and foot arteries. Oscillometric readings, Lower $\frac{1}{3}$ Rt.=2, L= $1\frac{1}{2}$.

COMMENT.—It is an established fact that quadruple ligation, with excision of the fistula, eliminates the likelihood of recurrence in cases of traumatic arteriovenous fistula. Likewise, there is little likelihood that gangrene will follow this procedure when done two or more months after injury. All concede that the procedure eliminates the deleterious effects of the disease upon the heart. Nevertheless, though the patient may be greatly improved symptomatically following this operation, the affected extremity is rarely capable of as full exertional response as the normal extremity without the occurrence of some symptoms.

A follow-up on three cases of traumatic arteriovenous fistula of the femoral vessels treated by ligation, with excision of the fistula were as follows: One man, age 26, reports discomfort in the calf of the leg when walking as long as two years after operation. A 29-year-old man, now four years since operation, is capable of walking only two miles at a slow pace without developing leg fatigue and pain; for this reason he was discharged from the Army. The third case, a professional dancer, age 30, has not been able to resume his work because of leg symptoms, now five years since operation. In none of these cases was the individual able to indulge in the vigorous sports or exercise to which they had been accustomed before receiving their injury. To compare with these results, we cite a case of arteriovenous fistula of the popliteal vessels upon whom one of us (A. H. B.) operated upon in 1934. Patency of the parent vessels was successfully maintained in this case, with elimination of the fistula by reconstructive aneurysmorrhaphy. The young man took up professional boxing after operation and has carried on with vigorous exercise, remaining completely symptom free. Now, eight years since operation, pulsation of the arteries is equal in the two feet. There was no section of sympathetics at operation in this case.

It would seem worth while to maintain the patency of the parent artery particularly in cases of arteriovenous fistula of the leg. We believe vein graft bridging, using the nonsuture technic, will make this feasible in a great percentage of cases. This affords a chance for complete restitution of function under all exercise conditions—an important item particularly to the soldier or young man. In our case the young man's greatest ambition was to regain his laurels as an amateur skater.

A case is presented illustrating the use of the nonsuture method of blood vessel anastomosis for vein graft bridging of the arterial defect following excision of peripheral arterial aneurysms.

Case 4.—No. 680199: E. P. A 62-year-old colored male was admitted to P. H., August 29, 1942, complaining of a painful, pulsating swelling on the inner side of the right thigh of four weeks duration. P. H.: Admits the presence of a primary lesion at age 20. P. I.: Onset of the swelling on the thigh followed two weeks after a sudden muscular effort to prevent a fall.

Physical Examination: A markedly arteriosclerotic individual appearing older than his years. B. P. 158/88; heart slightly enlarged. Examination of the right leg revealed a pulsating mass, 8 x 6 cm., over the region of the distal end of Hunter's canal. A systolic bruit was heard over the mass. Pulsation was present but diminished in the rt. popliteal and foot arteries. Laboratory: Kline +++++. Electrocardiogram revealed left axis deviation.

Operation.—Excision of the aneurysm with restoration of blood flow by vein graft bridging of the arterial defect, using the nonsuture method, double vitallium tube technic. The aneurysm arose at the femoropopliteal junction, and was 8 cm. in diameter. Thrombosis of the accompanying vein necessitated taking a segment of femoral vein from the left leg for use as a graft. The anastomotic magna artery was compromised by the pressure of the aneurysm. The parent artery was markedly arteriosclerotic with eggshell intimal plaques. The patient had been given dicoumerol preoperatively, with the idea of combining its use with heparin so the latter could be discontinued shortly after operation. A misjudgment in their use resulted in a two-hour clotting time for hours postoperatively. The amount of blood given necessary to overcome this caused cardiac decompensation, with massive edema, which resulted in our inability to palpate a pulse in either leg. Repeated oscillometric readings, however, revealed the anastomosis to be patent for 72 hours after operation. Fortunately, by this time, collateral circulation had developed sufficiently to maintain the viability of the leg. A diodrast study of the rt. femoral artery two weeks after operation confirmed the thrombosis of the anastomosis and demonstrated patent collaterals.

Follow-up: Patient was placed on antiluetic therapy. Buerger's exercises were continued because of inability to feel arterial pulsations in either foot. He returned to his work four months after operation, and has worked ever since. He states the right leg becomes more tired than the left on exercise. Now two years after operation.

COMMENT.—We did not attain the ideal, namely, the restoration of a normal, pulsating volume blood flow permanently through the parent artery in this case. However, the fact that the anastomosis did function for three days is, in our opinion, the reason why gangrene failed to occur following operation. Whereas, the presence of numerous sclerotic intimal plaques was undoubtedly responsible for the initiation of thrombus at the site of the anastomosis in this 62-year-old man. It seems likely that the diminished rate of blood flow, a result of cardiac decompensation, was a contributing factor. At any rate, it is reasonable to suppose that the anticoagulant therapy may have prevented extension of the thrombus to occlude important collateral branches.

It is not reasonable to expect maintained patency in the anastomosis of badly degenerated, arteriosclerotic vessels, irrespective of the method or adjuncts employed. It is our opinion that the nonsuture method will attain a high percentage of successes when employed in cases of syphilitic or traumatic peripheral arterial aneurysm not complicated by severe arteriosclerosis. In stating the above opinion, we hasten to caution against its indiscriminate use, however. Restoration of blood flow by vein graft bridging usually necessitates preliminary excision of the aneurysm. The latter procedure is far more destructive to collateral blood vessels than the operation of obliterative endo-aneurysmorrhaphy devised by Dr. Rudolph Matas. Therefore, the location of the aneurysm in relation to important collateral branches and other considerations in the particular case should govern the decision as to the

choice of methods, though all may agree that restoration of flow is the ideal and offers the best chance of complete restitution of function.

PORTAL-CAVAL ANASTOMOSIS BY THE NONSUTURE METHOD
FOR THE RELIEF OF PORTAL HYPERTENSION

A more common cause of portal hypertension is obstruction to the flow of portal blood through the liver due to Laennec's (portal) cirrhosis. Or, cases of congestive splenomegaly (Banti's syndrome) in which the obstruction may be in the portal or splenic veins. It has long been appreciated that the successful establishment of a portal-caval shunt would have a beneficial effect upon the control of bleeding in the gastro-intestinal tract the result of portal hypertension. The technical ease with which blood vessel anastomosis may be accomplished, using the nonsuture, vitallium tube method, naturally suggested its application to this vascular problem.

With the valued cooperation and skillful aid of Dr. Allen O. Whipple we have been able to establish end-to-end anastomoses between the splenic and left renal veins following removal of the spleen and kidney in five cases. Operation upon two cases of cirrhosis has been too recent to evaluate the results.

Case 5.—No. 690444: A. P. A five-year-old girl of Polish parentage was first admitted to P. H. in October, 1942, with the complaint of abdominal enlargement of three months' duration. Family and past history noncontributory. Present illness: Onset with progressive enlargement of abdomen and anorexia. Mother had noticed an increasing tendency to bruise following minor traumata.

Physical Examination: The child appeared chronically ill. The pertinent findings were confined to the abdomen. The latter was protuberant, with visibly distended venous channels. There was no free peritoneal fluid. The liver was enlarged 8 cm. below the costal margin and was firm, with a sharp border. The spleen extended 10 cm. below the costal margin and was very firm. Studies revealed a moderate derangement of liver function. *Diagnosis:* Portal cirrhosis, congestive splenomegaly. The child was placed on a high protein, high vitamin diet and discharged December 1, 1942.

Readmitted to P. H. May 25, 1943. General condition unimproved. On examination, the child was markedly anemic. The liver and spleen remained enlarged as before. Three transfusions were given during the next two weeks. A stool examination was positive for blood. Though an esophagram failed to show esophageal varices on the 15th day after admission, the child began to vomit large quantities of blood. For several days blood replacement was carried out by continuous transfusion. During the ensuing month the child's condition remained desperate. Her hemaglobin could not be maintained above the low forties. The ascites that had supervened became irreversible.

Operation.—July 26, 1943: The child's abdomen was explored with the hope that blood could be shunted from the portal to the caval systems by anastomosing the splenic to the renal vein, employing the nonsuture technic.

Pathology: The liver was markedly cirrhotic; the spleen eight to ten times normal in size. There was considerable collateral circulation between the splenic, gastric and omental vessels. Considerable ascitic fluid was present. The right and left kidneys appeared normal.

Procedure: A long left rectus incision was made. The spleen was mobilized. The splenic artery ligated. The splenic vein was closed by a serrefine clamp, sectioned near the spleen and the latter removed. The splenic vein was then dissected proximally for a distance of 8 cm. and irrigated with normal saline. The tail of the pancreas and the left kidney were mobilized. The renal artery and ureter were ligated and cut. The

renal vein was mobilized throughout its length. A serrefine clamp was applied proximally and the vein sectioned near the kidney.

Anastomosis: The end of the splenic vein was passed through a special vitallium tube, and everted (cuffed) over the tube. The vein was held in place by a No. 1 Deknatel silk ligature tied tightly behind a holding ridge on the tube, some 5 Mm. from the end. The renal and splenic vein stumps were irrigated with normal saline. The vitallium tube bearing the cuffed end of the splenic vein was then introduced into the stump of the renal vein. The latter was drawn well up on the tube and secured by a No. 3 Deknatel ligature passed around the two veins over the tube and tied tightly behind the above-mentioned holding ridge. This afforded a broad splenic vein intima-to-renal vein intima contact. A second ligature of No. 1 Deknatel silk was tied, just snug, near the end of the vitallium tube (Fig. 1), to prevent blood from penetrating between the intimas. 15 mg. (1.5 cc.) of heparin (liquaemin) was given intravenously. The serrefine clamp on the splenic vein was removed quickly followed by removal of the serrefine clamp on the renal vein. Upon opening the anastomosis blood rushed through from the portal system *via* the splenic vein into the caval system *via* the renal. There was slight angulation of the splenic vein over the funnel edge of the tube.

Closure: The abdomen was closed with near-and-far steel wires; the skin with interrupted silk.

Condition: The patient left the table in fair condition, having received a transfusion of plasma and blood during the operation.

Postoperative Course: Heparin was continued by intravenous drip for two days. On the second day she became distended, dyspneic and stuporous. The temperature rose to 104° F. Oliguria developed, and moist râles appeared throughout the lungs. The nonprotein nitrogen rose to 85 mg. per cent. The exact cause of the unfavorable course was unknown, but it was felt that "hepatorenal" failure was a contributing factor. A duodenal tube was passed. Large amounts of fluid, blood and massive parenteral doses of vitamin "B" complex were given with sudden dramatic results. Kidney function improved. Nonprotein nitrogen dropped to 43 mg. per cent on the fifth postoperative day, and convalescence from then on was uneventful.

Pathologic Findings: Liver cells (microscopic), varying in size, were accumulated in large and small islands between wide bands of connective tissue. Spleen microscopic sections revealed the usual picture of congestive splenomegaly. Examination of the left kidney revealed numerous cysts, 0.5 to 2 Mm. in diameter, scattered throughout the cortex and medulla. The cysts were lined with flattened epithelium. In addition, small, wedge-shaped areas of scarring and cellular infiltration occur. In them the glomeruli are sclerotic, the tubules dilated and filled with hyaline casts. Lymphocytes predominate in the cellular exudate.

The diagnosis of congenital cystic kidney with superimposed infection was a discouraging finding in this case. However, reevaluation seven months postoperatively revealed that she had gained four pounds, had a good appetite, and played actively. There had been no recurrence of the ascites. The superficial collateral veins over the abdomen had receded markedly (Fig. 7). There was improvement in the hemoglobin (12.5 Gm.); stool guaiac-negative for blood. Urine: Concentrated specimen showed many hyaline casts, few R. B. C. and W. B. C., sp. gr. 1.009, and a faint trace of albumin. N. P. N. 42.9 mg. per cent, urea ratio 50.6. Phenolsulphonephthalein excretion 50 per cent. Many determinations of B. P. ranged from 110/76 to 126/80.

Reevaluation 12 months: Postoperative July 17, 1944. Appetite good. Gaining in weight. No bleeding episodes, though mother states the child "bruises easily." Examination: B. P. 124/76. Superficial abdominal veins not prominent. No edema or ascites. Liver edge 6 cm. below costal margin. Laboratory: hemoglobin 11.3; R. B. C. 3,500,000. Urine: Sp. gr. 1.016; alb. ft. tr., microscopic shows few W. B. C. N. P. N. 46.4, urea N. 36.7, urea ratio 79.1. Total proteins 7.6. Albumin 4.08 Gm., globulin 3.53 Gm. Stool guaiac-negative for blood.

NONSUTURE BLOOD VESSEL ANASTOMOSIS

Summary of the test pertaining to the liver status before operation, 6 and 12 months after operation is as follows: No change in protein partition. (Albumin and globulin ratio was never reversed.) An elevated prothrombin time before operation returned to normal after operation. A three plus cephalin flocculation test and an increased bromsulphalein have surprisingly returned to normal after operation, while the galactose tolerance and hippuric acid conjugation tests have shown increased impairment.

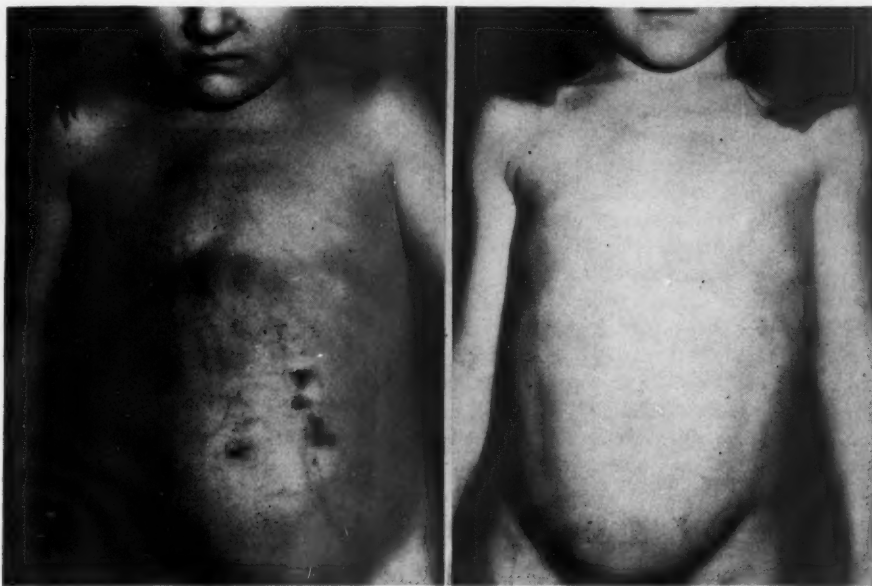


FIG. 7A

FIG. 7B

FIG. 7.—A. & B. Infra-red photographs of the superficial collateral veins in Case V. Photograph A. was taken 26 days following the establishment of a portal-caval shunt. B. Was taken 15 months after the establishment of the portal-caval shunt.

The patient continued to do well until October 8, 1944, when she felt weak, dizzy, and passed three tarry stools. Her mother gave the story of a recent nosebleed. She was admitted to B. H. and given multiple transfusions over a period of eight days. The initial hemoglobin of 50 per cent rose to 82 per cent. The liver was enlarged, as before. No ascites present. Even after complete restoration of her blood volume, no increase in distension of the superficial abdominal veins was noted (Fig. 7). She entered the hospital with an N. P. N. of 90, which two days later had fallen to 47.9. This was a higher N. P. N. figure than recorded during the days of the hepatorenal failure immediately after operation. The diastolic blood pressure was consistently higher on this admission and the systolic somewhat higher. During the year and three months since operation, the child has increased in height from 40.25 inches to 44.75; weight from 33 lbs. to 48 lbs. She was discharged October 21, 1944, having a guaiac negative stool.

SUMMARY: A five-year-old child diagnosed as portal cirrhosis who, after eight months, developed massive hemorrhages from esophageal varices and ascites. A portal-caval shunt was established following removal of the spleen and left kidney. Examination of the kidney revealed the additional diagnosis of congenital polycystic disease. The general health of the child improved markedly after operation and this improvement was maintained over a period of 15 months. There was improvement in some of the liver function tests and no return of the ascites. Frequent examinations of the kidney, however, showed gradual increased impairment. At 14 months postoperatively the child had a nosebleed, and a few days later passed a tarry stool. The blood pressure (systolic

and diastolic) averaged higher than previous levels, and the N. P. N. was 90. She responded to transfusions and is now back at school.

Case 6.—No. 756752: M. A. A 15-year-old girl was admitted to P. H., August 17, 1944, with the history of repeated massive hemorrhages into the gastro-intestinal tract since the age of four. Such attacks were characterized by tarry diarrhea and coffee ground vomitus followed by the vomiting of bright red blood. The attacks would last from one day to one week, and it had been repeatedly noticed that the spleen, which was enlarged, would shrink considerably following each episode of hemorrhage. During the past four years the patient had experienced at least four attacks, the most recent one having occurred two months prior to admission. Family and past history otherwise unremarkable.

Physical Examination.—This revealed a normal-appearing girl, with the only positive finding of an enlarged spleen extending downwards to the level of the umbilicus. The liver was not enlarged and there were no prominent veins over the abdomen, nor were there evident hemorrhoids. There was no evidence of ascites. Laboratory findings of interest included evidence of esophageal varices at its lower end; normal serum protein and albumin-globulin ratio; normal bromsulphalein test; R. B. C. of 3.9 million, Hb. of 12 Gm.; W. B. C. of 4,300, and smear showed a reduced number of platelets.

Course: After the establishment of normal renal function bilaterally by intravenous pyelography, the patient was operated upon on the 6th hospital day. The liver was found to be normal; and an anastomosis, using a 7-Mm. vitallium tube, was established between the splenic vein and the left renal vein, following the removal of the spleen and left kidney. Measurement of the pressure in a branch of the coronary vein before the anastomosis was 310 Mm. of water and following the establishment of the anastomosis it fell to 190 Mm. of water. The postoperative course was uneventful, and she left the hospital on the 15th postoperative day.

Follow-up: Feels well. Has gained 10 lbs. No recurrence of bleeding; now three months since operation.

Case 7.—No. 754188: J. C., a 38-year-old male, was admitted to P. H. August 10, 1944, complaining of a sensation of discomfort in the left flank of seven months' duration. For two months the patient had felt weak and tired. Three weeks later he developed an acute polyarthritis, associated with fever. Improvement in the joint symptoms occurred in one week, but for the three weeks prior to admission the patient had noted dark urine and mild diarrhea. There had been no jaundice, ascites, vomiting or evidence of bleeding.

P. H. revealed an attack of "yellow jaundice" associated with light stools of three weeks' duration at the age of 17 years. There was no history of exposure to hepatotoxic agents.

Physical Examination.—A well-developed male, without jaundice; the liver edge was 2 cm. below the costal margin at the midclavicular line, and the spleen was 7-8 cm. below the left costal margin. Laboratory findings revealed the following: Hb. 13 Gm., R. B. C. 4.3 million; W. B. C. 6,000, with a normal differential count; platelets 66,000; urine free from bile. Kline: Negative. Prothrombin time (Orrich) 30.8 seconds; capillary and red blood cell positively normal. Bromsulphalein test: 60 per cent retention in 30 minutes; cephalin flocculation test: 3 plus; phosphatase 6; serum protein 7.5 Gm.; albumin 3.5 Gm.; (A. G. ratio reversed) globulin 4.0 Gm.; bilirubin 1.5 mg. Chest film normal. Plain film. Enlarged spleen. Complete cystoscopy, with retrograde pyelograms, showed no abnormality. A roentgenogram of the esophagus showed early varices.

Course: The patient was treated with a high vitamin, high carbohydrate, high protein, low fat diet, supplemented with Brewer's yeast, liver and betabione. On the 27th hospital day the patient was operated upon and a moderate amount of ascitic fluid was present. Following the removal of the spleen (weight 620 Gm.) and left kidney, an

anastomosis between the left renal vein and splenic vein was carried out, using an 8-Mm. vitallium tube. The pressure in the coronary vein before the anastomosis was completed was 400 Mm. of water, and following the completion of the anastomosis the pressure measured 240 Mm. of water. A biopsy of the liver revealed Laennec's cirrhosis of the liver with a moderate degree of healthy-looking hepatic cells in the areas of regeneration. The postoperative course was complicated by a mild bronchopneumonia, and it was necessary to perform several paracenteses. He was discharged, on the 21st postoperative day.

Follow-up: Six weeks following operation the patient's only complaint is some itching of the skin. He has a good appetite. Has gained weight and strength. On examination, he appears much improved. His color is good. There is no evidence of ascites. Laboratory findings: Serum total proteins 6.7 per cent, S. G. 4. S. A. 2.7. N. P. N. 33 mg. per cent. Serum bilirubin 2.1 mg. per cent. Cholesterol 251 mg. per cent. Inorganic phosphatase 3.5 mg. per cent. Alkaline phosphatase 8.9 Brodsky units. Hippuric acid excretion after one hour = 0.5 Gm. Cephalin flocculation test = \pm .

COMMENT.—Whereas, there have not been a sufficient number of cases operated upon, nor has there been sufficient time elapsed since operation to judge the efficacy of this procedure, the results, so far, appear to warrant further trial.

The recurrence of an episode of bleeding in the child with cirrhosis (Case 5) 14 months after operation does not, in our opinion, necessarily mean that the portal-caval shunt has become blocked. It may mean, due to the effects of nitrogen retention upon blood pressure, *etc.*, that the combined blood-carrying capacity of the shunt and the collateral vessels were overtaxed for the time.

SUMMARY

A nonsuture method of blood vessel anastomosis, using vitallium tubes, is presented. Cases are reported to illustrate its use in acute traumatic vascular injuries, traumatic arteriovenous fistulae, peripheral arterial aneurysms, and the establishment of portal-caval shunts for the relief of portal hypertension.

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DISCUSSION.—DR. ALFRED BLALOCK, Baltimore, Md.: Last year at the meeting of this Association I took the liberty of speaking about Doctor Blakemore's method for wiring aneurysms and of the excellent results which he has obtained. I am sure that this method has not received the amount of attention it deserves. I am delighted that Doctor Blakemore is here in person this year and that he has presented work on the use of a nonsuture method for bridging gaps in blood vessels.

I would like to describe briefly the result which followed the use of the vitallium tube in connecting the splenic vein and the renal vein in a patient with cirrhosis of the liver. This patient, age 47, became ill 18 months ago. It was noted that the abdomen had increased in size. She entered Johns Hopkins Hospital in February of this year, and it was necessary to tap the abdomen frequently, approximately six liters of fluid being removed each week. There was a temperature elevation each day to approximately 102° F., and the patient's condition was considered very poor. About a month following entrance to the hospital a left transverse abdominal incision was made and the spleen and left kidney were removed. The spleen showed scarring and congestion and a section of the liver showed advanced cirrhosis. The splenic vein was then anastomosed to the left renal vein by the use of a vitallium tube. The patient's postoperative course was fairly uneventful. Fluid accumulation within the abdominal cavity continued for a while, but at a somewhat reduced rate. The fluid accumulation apparently stopped during June, and she has not had to be tapped for almost six months. (slide) This slide shows the vitallium tube in place, and this slide is a recent photograph of the patient; there is no evidence of ascites.

The nonsuture method for connecting blood vessels is of great value when the ends of vessels cannot be approximated without tension. I do not think that the nonsuture method has particular merit in the case of anastomosis of the splenic and renal veins. Anatomically, these structures lie very close to each other and I think it is probably better to anastomose the veins directly, end-to-end, without the use of tubes. As a matter of fact, we performed such an anastomosis several weeks ago and no unusual difficulties were encountered. These remarks are in no way meant to detract from the value of the method which has been devised by Doctors Blakemore, Lord, and others.

As I have indicated, and as is generally known, it is not always necessary to use a tube in anastomosing blood vessels. Doctor Taussig and I have been working on the hypothesis that an artificial patent ductus would be helpful in the treatment of pulmonic stenosis. Approximately a week ago we anastomosed the proximal end of the divided left subclavian artery to the side of the left pulmonary artery. This was done by arterial suture. The time since operation has been too short to know whether this 15-months-old child will be improved. When one can anastomose vessels by the suture method without undue tension, it seems to me that the procedure is preferable to the use of a large foreign body. This statement is made with full realization that there are many instances in which part of the length of vessels is destroyed, in which a tube must be used if the continuity of the vessel is to be restored. It is in such instances as these that the Blakemore method would result in the saving of structures which would otherwise be lost.

DR. RUDOLPH MATAS, New Orleans, La.: I cannot resist the tempting opportunity to join in the discussion of Doctor Blakemore's paper, as I have been deeply interested in the success of his experimental studies ever since their publication. When I first learned the details of his technic, I looked upon his sutureless method of uniting divided arteries as the culminating point in the long history of arterial reconstruction and repair, and the solution of a problem which for nearly two centuries has exercised the ingenuity of surgeons. The ideal of surgery in dealing with injuries of the great arteries has been, always, to restore the continuity of the circulation directly through its main channels independently of the secondary or collateral branches. The innumerable methods which have been devised to unite divided arteries suffices to show the importance attached to this principle and the difficulties that have been in the way of its performance.

The great merit of Blakemore's work is that in his efforts to simplify and perfect his sutureless method of repairing and rehabilitating wounded arteries, he has devised

NONSUTURE BLOOD VESSEL ANASTOMOSIS

a technic which utilizes all that is best in the experience of his predecessors while availing himself of contemporary discoveries in hemo- and chemotherapy which have profoundly modified and improved the treatment of war wounds. In this way he has created a new type of vascular anastomosis which is the embodiment or synthesis of all that is best in the old and in the new of vascular surgery. By dispensing with the delicate and time-consuming methods of suture, and by utilizing preserved heterogenous venous grafts, already mounted on vitallium tubes, he has reduced the time limit of anastomosis to its minimum terms. Besides these technical innovations, he has reinforced his defences against infection by resorting to the sulfas and penicillin; and against thrombosis, by the systematic use of heparin. In this way he has accomplished the great objective of his endeavors by making the rehabilitation of damaged arteries practicable at the battle fronts, in the field hospitals where vascular rehabilitation is most indicated. In this respect he has improved on the practice of the German surgeons in World War I, who anastomosed the arteries by suture on the Carrel principle (with and without venous grafts) and made this the method of election in dealing with the main arteries, only resorting to the ligature for minor vessels. These operations were performed chiefly at base hospitals for pulsating hematomas and traumatic aneurysms which could wait for deliberate treatment.

Their statistics show that, despite a considerable number of failures by thrombotic occlusion and other causes, the results in the saving of limbs from amputation were, in general, decidedly better than those obtained by the permanent ligation of the vessels involved, with sole dependence on the collateral circulation.

It is evident that Doctor Blakemore, by applying his simplified and quick method of anastomosis, has made this procedure as available in the field as in the rear hospitals and, in so doing, has added a most valuable and timely contribution to vascular surgery in general and to war surgery in particular. And this is important in view of the great increase in the number of wounds of the lower extremities caused by ground mines and fragmentation of explosive shells and bombs, *etc.*, which are so extensive and destructive to the soft parts that they not only damage the main arteries but a large area of the regional collaterals, with consequent increase in the amputations of the lower extremities.

In going over Doctor Blakemore's publications I have been impressed by the earnestness and scientific ability with which he, and his associates, have pursued their experimental work and the ingenuity with which they have overcome obstacles which have blocked the way of their predecessors (*e.g.*, preserving, preparing and utilizing heterogenous venous grafts on a large scale—a sort of bank of venous grafts).

It is noteworthy that Doctor Blakemore has not minimized the importance of the collaterals, despite his special plea for the major circulation. In fact, he is concerned in the best means of prolonging their functional efficiency. His classifications of war wounds according to the extent and degree of the damage done to the circulation shows that he is not indiscriminate in the selection of the cases in which his reparative anastomosis is really indicated.

After reviewing the experimental and clinical evidence of the practical efficiency of the "sutureless anastomosis" so convincingly presented in Doctor Blakemore's publications, it would seem that nothing remains but to test his procedure at the battle front, in the special type of casualties which this monstrous war so abundantly and unfortunately provides.

In the meantime, Doctor Blakemore, and associates, are entitled to congratulations and praise for an achievement which marks the most notable advance in the contemporary surgery of the peripheral blood vessels.

DR. ARTHUR H. BLAKEMORE, New York, N. Y. (closing): Doctor Blalock has presented two cases of cirrhosis of the liver in which he performed splenic-venal vein anastomosis for the relief of portal hypertension. He demonstrated, in the second case, his complete mastery of blood vessel suture technic in choosing to perform a suture anastomosis. This was a surgical feat deserving of the highest congratulations.

I want to express my appreciation to Doctor Matas for his most generous remarks. I welcome this opportunity to thank Doctor Matas in behalf of my associates and myself for the many wise and helpful suggestions he has given us in the development of this work.

END-RESULTS IN THE TREATMENT OF HYPERPARATHYROIDISM*

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THE EARLY THIRTIES were the golden years of progress in the surgery of the parathyroids in this country. Pioneer work was done by Ballin and Morse,¹ of Detroit, but the Boston group easily outstripped all the other clinics by finding and operating upon 78 cases in 12 years.^{2, 3, 4} Since Cope, of that group, maintains that this large series was attained without a great number of referrals from a distance, it seems almost necessary to postulate a geographic factor. During the same period, only 15 cases of hyperparathyroidism, proved at operation, were encountered at the Mayo Clinic,⁵ and only six cases have been recognized at the Henry Ford Hospital. Undoubtedly, both of these clinics were well enough aware of at least the skeletal manifestations of the disease at an early date because Pemberton's⁶ successful removal of a parathyroid adenoma antedated the operation on Case I of the Boston series by more than a year and, in 1931, one of us (R. D. McC.) searched for an adenoma in the neck of a patient with marked osteoporosis. The pathologist could find no parathyroid tissue in the excised specimens, and in the light of fuller knowledge of calcium metabolism, this particular case cannot be classified as one of hyperparathyroidism, but it may be worth while to record that following exploration and partial thyroidectomy, the patient ceased to have bone and muscle pain for which he had sought relief. He died four years later of carcinoma of the sigmoid.

No attempt will be made to give a complete account of all the symptoms and signs which may be encountered in disease of the parathyroid glands. The history of urinary calculi, skeletal abnormalities, particularly pathologic fractures, bone and muscle pains and even such general symptoms as lassitude and constipation should arouse suspicion. Roentgenograms of the skull and long bones give confirmatory evidence. Laboratory tests clinch the diagnosis. Typically, there is elevation of the serum calcium and phosphatase, and lowering of the serum phosphorus. There is a negative calcium balance as a result of the increased urinary excretion. The urine test described by Sulkowitch gives a rough estimation of this calcium loss.⁷

In our small series of six cases may be found examples of all of the clinical types of hyperparathyroidism, classic von Recklinghausen's disease, osteoporosis with and without renal stones, renal stones alone and a type which has been called acute parathyroid poisoning. It is to the credit of the Boston group that their series included no instance of the latter type, which is associated with the implication that specific surgical treatment was withheld or delayed until there was a fatal issue. Such was the unfortunate

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HYPERPARATHYROIDISM

result in Case 1 of our series, which is included even though the patient was never seen by a general surgical consultant.

CASE REPORTS

Case 1.—K. E. (169909) was a white woman, age 44. She was admitted to the Henry Ford Hospital, November 3, 1931, with the complaint of pain in the right chest and right thigh. Four months before, she had sneezed violently and felt a tearing sensation in the right side. Pain persisted, and two months later there was also discomfort in the right thigh. Just previous to admission, the symptoms of dyspnea,



FIG. 1.—Case 3, shortly after operation. Note the extreme emaciation.

weakness and anorexia appeared. The chief finding on physical examination was dullness at the right lung base, which was correctly interpreted as fluid. Three hundred cubic centimeters of serosanguineous fluid was removed by thoracentesis. An examiner reported that this fluid contained "many blood cells and a few large cells with abundant cytoplasm and hyperchromatic nuclei suggestive of a malignant process."

Roentgenograms of the right femur showed: "A destructive process involving the lower one-third of the bone. There are several areas of decreased density seen in the anteroposterior position which would appear to be separated from each other by more or less normal bone. The picture suggests metastatic malignancy."

These two "suggestive" findings were so convincing that an excellent internist then stated: "Further investigation is of academic interest only. She is financially unable to have more studies, and from the practical standpoint, it makes no difference since in any event the outlook is hopeless. She should be kept in bed to prevent a pathologic fracture." Deep therapy was administered to the femur and she was discharged on December 2, 1931. She was readmitted on December 26, 1931, on account of inability to eat and vomiting. In four days of symptomatic treatment, she felt well enough to go home. As she stepped into a waiting automobile, the left leg collapsed. She was carried back to her room, and roentgenograms showed a pathologic fracture of the lower third of the femur, for which skin traction was applied.

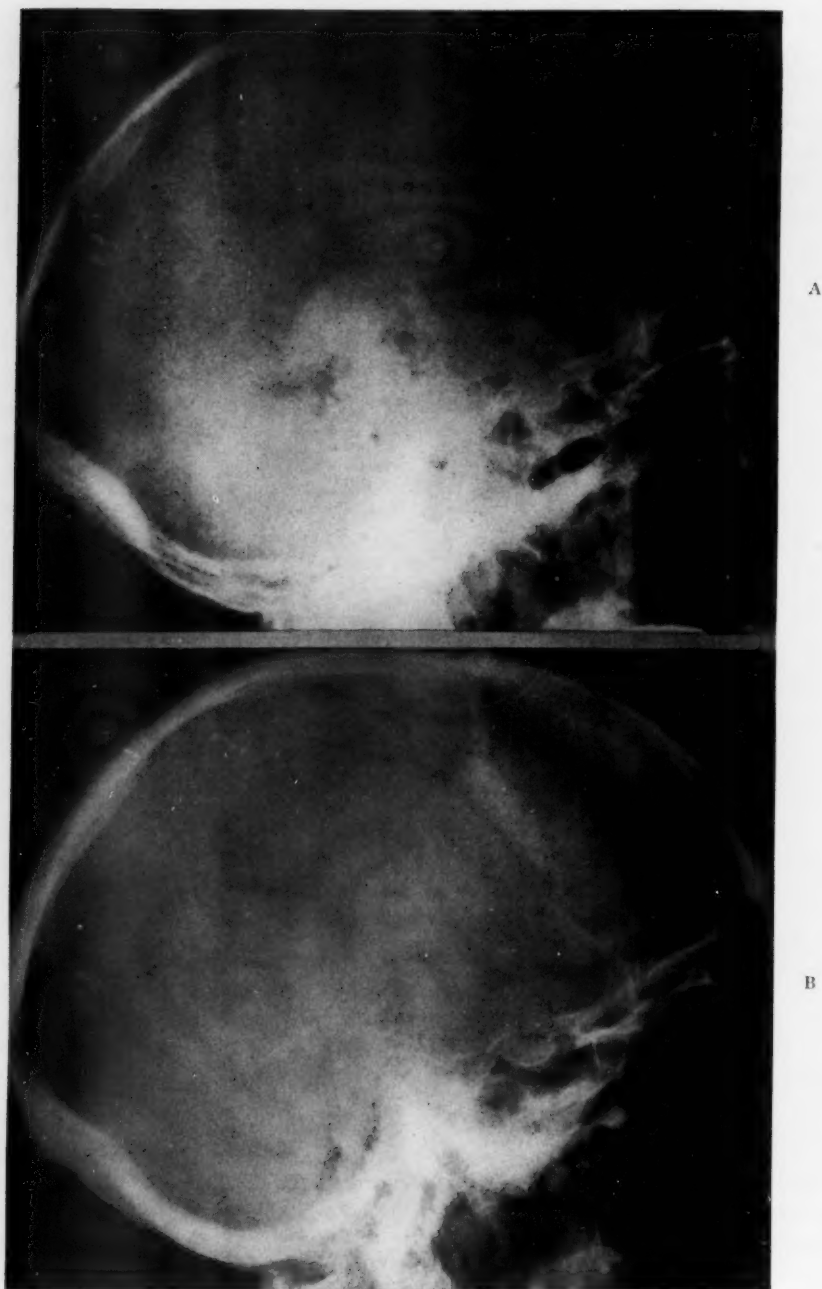


FIG. 2

FIG. 2.—A. Skull before operation, Case 3.
B. Skull eight years later; normal appearance.

HYPERPARATHYROIDISM

Dr. Carl Badgley saw the patient on December 31, 1931, and stated: "The development of pathologic fracture in the left leg, with roentgenologic evidence of cystic degeneration with similar lesions developing elsewhere in the skeletal framework, makes the possibility of a parathyroid lesion resulting in an osteitis fibrosa cystica presumptive. We would like to know how authoritative the report of the malignant cells in the pleural fluid is. Calcium and phosphorus studies are advised. Also, it is suggested that Doctor McClure see the patient in consultation with regard to the advisability of parathyroid surgery." On this day the serum calcium was 14.3 mg. and the phosphorus was 2.57 mg.

January 8, 1932. Continues to be nauseated and vomits nearly every day.

January 13. Serum calcium, 19.4 mg., phosphorus, 3.88 mg.

January 20. Hemoglobin 9.2 Gm. Mental status very cloudy.

January 25. Carbon dioxide combining power, 68.5 vols. per cent. (alkalosis from vomiting).

February 13. Temperature higher. Patient very pale, with a waxy appearance. Serum calcium, 14.2 mg., phosphorus 6.25 mg.

February 14. Patient weaker, unable to drink through tube. Temperature 103° F.

February 15. Patient expired.

Autopsy: It was found that the parathyroid glands were diffusely enlarged, and the microscopic picture was that of hyperplasia. There were calcium deposits in the lungs, kidneys and blood vessels. The cystic areas in the bones showed the usual picture of advanced osteitis fibrosa cystica.



FIG. 3.—A. Femur, Case 3, before operation; shows lacunar osteoporosis.
B. Femur, eight years after parathyroid tumor was removed.

This case is very similar to that reported by Hanes.⁸ Dr. Fuller Albright wrote Dr. Hanes: "It is my belief that your patient died of parathyroid poisoning which is a complication of hyperparathyroidism, which occurs when the blood calcium rises above a certain critical point. At this critical point the serum phosphorus, instead of being low, starts going up because phosphorus is no longer diffusible at very high levels of calcium. The thing which would have alarmed me about your case was not so much the high calcium as the absence of low phosphorus." Surgery was not carried out on Hanes' case on account of the unexplained fever. In our case, the record fails to disclose why the suggestion of a general surgical consultation was not followed through.

Case 2.—Already reported in the surgical literature:⁹ E. D., (196988), female, age 51, showed the lesions of typical osteitis fibrosa cystica and a pathologic fracture of a femur. In March, 1934, a cystic parathyroid adenoma imbedded in the lower part of the right thyroid lobe was removed. There was immediate symptomatic improvement, but

the patient expired four months later in an hypoparathyroid state. It must be presumed that the blood supply to the remaining normal parathyroid glands was disturbed by the operative procedure.



FIG. 4.—Parathyroid adenoma removed from Case 3.

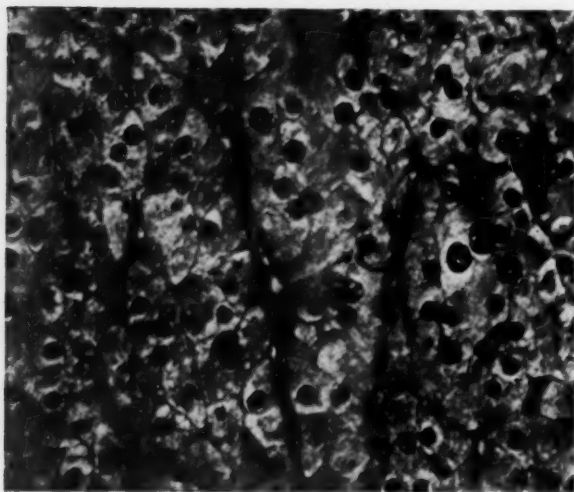


FIG. 5.—Photomicrograph of tumor from Case 3. It is composed of oxyphilic cells.

It is more of a pleasure to report on the follow-up of the remaining four cases in our series.

Case 3.—J. H., (229176), a toolmaker, age 51, was admitted on January 18, 1936, complaining of "rheumatism" of seven years duration. Over this period, stiffness and pain which began in the feet gradually involved the knees, shoulders and elbows. Marked muscular weakness appeared and this progressed to the point where walking was difficult. Constipation was troublesome. There was a weight loss of 30 pounds. The patient

HYPERPARATHYROIDISM

presented a picture of cachexia (Fig. 1). There was little or no subcutaneous tissue; the flaring costal margins accentuated the scaphoid appearance of the abdomen. Generalized bone tenderness was present. The dorsal spine was kyphotic. Urinalysis was normal. Wassermann negative. The blood count indicated secondary anemia, with 3,400,000 red blood cells and 45 per cent hemoglobin.

The marked emaciation, anemia and constipation suggested the provisional diagnosis of gastro-intestinal malignancy. However, Dr. F. J. Sladen noted that the past history contained a note of three attacks of urinary stone passage and suggested studies of parathyroid function. Roentgenograms of the skull showed the typical granular appearance (Fig. 2 A) and the long bones showed osteoporosis of the lacunar type (Fig. 3 A). There was marked demineralization of the spine. Small areas of calcification were seen throughout both kidney area. The diagnosis of hyperparathyroidism as confirmed by the finding of a serum calcium of 19.3 mg., serum phosphorus of 3.53 mg., and phosphatase of 7.13 Bodansky units. Careful examination of the neck revealed the probable existence of a nodule in the region of the right lobe of the thyroid gland.

Operation.—February 5, 1936: The usual thyroid exposure was affected. A plum-sized tumor lay behind the right lobe of the thyroid, displacing it forward. It could be lifted out of its bed easily, since the vascular attachments were long. The tumor weighed 13 Gm., and measured 3 x 2.5 x 1.7 cm. (Fig. 4). Microscopic examination of the tumor revealed it to be an adenoma composed chiefly of oxyphil cells (Fig. 5).

The day following operation, the patient stated that he felt better than he had in months. On the second postoperative day, the serum calcium was 9 mg. and five days later it was 7.8 mg. He was given a high calcium diet and cod liver oil. On March 2, an inguinal hernia was repaired and he was discharged shortly thereafter. He returned to work in May. By November, he had gained 44 pounds. The recalcification of the bones was watched by frequent roentgenograms. Two years after operation, there was little abnormal. Recent pictures of the skull and a femur show normal bone architecture (Figs. 2 B and 3 B). Slight calcification in the kidney areas has persisted and the patient recently consulted the Urology Department about mild urinary symptoms. The phenolsulphonphthalein test showed normal kidney function. His general health is excellent, and he works regularly as a toolmaker in a war plant (Fig. 6).

Case 4.—C. B., (50822), white, male, age 19, was seen in consultation by the senior author at the Charles Godwin Jennings Hospital in January, 1938. The patient had been troubled with renal calculi since August 1, 1937. Early roentgenograms (Fig. 7) had shown a number of stones on the right side and one on the left. Several cystoscopic procedures were carried out by Dr. G. E. Chittenden during the next four months. There was marked increase in the size of the stones in the right kidney (Fig. 8), and on January 12, 1938, Doctor Chittenden removed some of the stones by pyelotomy and left in a nephrostomy tube. Progress roentgenograms showed many stones remaining. On January 26, the serum calcium was 15.8 mg. Dr. Robert C. Moehlig saw the boy in consultation and advised exploration of the neck for parathyroid tumor. A radiograph of a femur showed little deviation from the normal.



FIG. 6.—Case 3, eight years after operation.

Operation.—February 1, 1938: The vicinity of the right lobe of the thyroid was explored first and no definite parathyroid tumor could be found. At the tip of the lower pole, attached to the thyroid gland, was a small round body about one centimeter in diameter, with the brownish-red color of thyroid tissue. The left lobe was then examined and nothing unusual was found in contact with any part of it. About one centimeter below and lateral to the lower pole, there could easily be seen a definite, smooth,



FIG. 7.—Roentgenograms of kidney areas on October 15, 1937. Case 4.

encapsulated oval structure, about $2 \times 1.5 \times 1$ cm. in dimensions, of about the same consistency as normal thyroid tissue and for the most part, of a brownish-red color. The structure was loosely attached to the base and sides of the left thyroid fossa by delicate blood vessels and areolar tissue. This was thought to be the parathyroid tumor, and it was excised. The nodule attached to the lower pole of the right lobe of the thyroid was also removed. The pathologist, Dr. F. W. Hartman, reported that the ovoid tumor from the left side was a parathyroid adenoma composed mainly of chief cells, while the nodule from the right was thyroid tissue (Fig. 9).

His convalescence was uneventful. Roentgenograms ten days later showed a diminution in the size of the calculi in the right kidney. On February 14, the serum calcium

HYPERPARATHYROIDISM

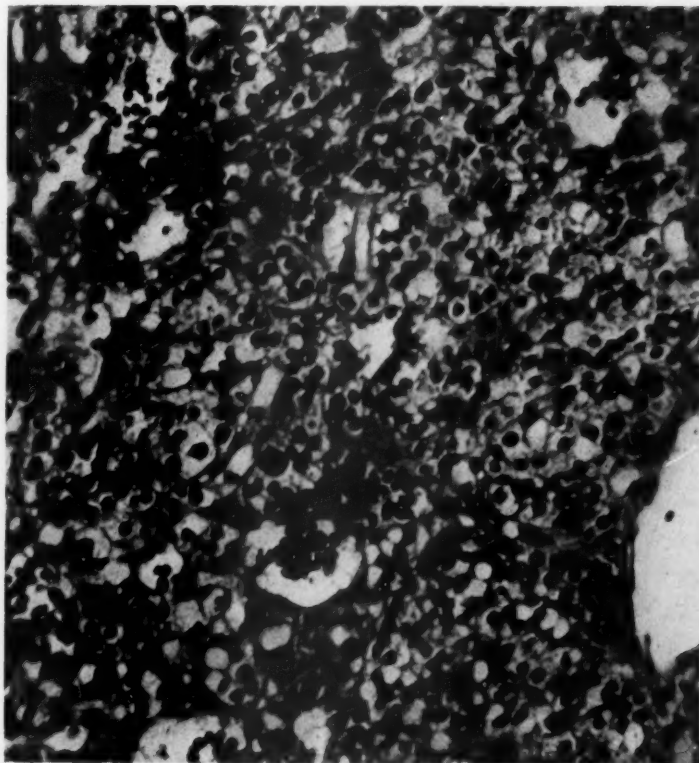


FIG. 9.—Photomicrograph of parathyroid tumor removed from Case 4.



FIG. 8.—Plain film of right kidney area, January 12, 1938, Case 4.
There has been an increase in the size of the stones.

was 10.9 mg. Roentgenograms taken on August 2, 1938, showed no sign of calcification about the kidneys (Fig. 10). Six years later, in August, 1944, there were no urinary symptoms and no roentgenographic evidence of stones.

Case 5.—R. K., (287639), white, female, age 14, was admitted on the orthopedic service, February 6, 1939, complaining of "knock-knees." The legs had been straight a year before, but there had been rapid development of the genu valgum deformity



FIG. 10.—Roentgenograms of kidney areas on August 2, 1938, Case 4, showing disappearance of all kidney stones.

(Fig. 11 A). For several months, she had been taking extra calcium and vitamin D on the advice of her physician. The serum calcium averaged 15.3, the phosphorus 2.61, and phosphatase 6.37 Bodansky units. A calcium balance study showed a calcium excretion of six times normal. Roentgenograms of the knees showed the marked genu valgum deformity with persistence of the epiphyseal lines. Osteoporosis, with coarse trabeculation, was seen in the long bones and the skull showed a granular type of osteoporosis.

Operation.—March 4, 1939: The region of the right lobe of the thyroid was explored first, and no tumor was found. On the left, below and lateral to the lower pole, there was a bean-shaped body, measuring 2 x 1 x 1 cm., darker red in color than thyroid

HYPERPARATHYROIDISM

tissue (Fig. 12). The tumor was found to be an adenoma composed of chief cells (Fig. 13). On the second postoperative day, the patient had a positive Chvostek sign and some numbness and tingling of the fingers. Calcium and viosterol medication was started immediately and the signs of impending tetany disappeared within a few hours. Convalescence was otherwise uneventful. Three weeks after the operation, the serum calcium was 10.2 mg., phosphorus 3.04, and phosphatase 4.39 units.

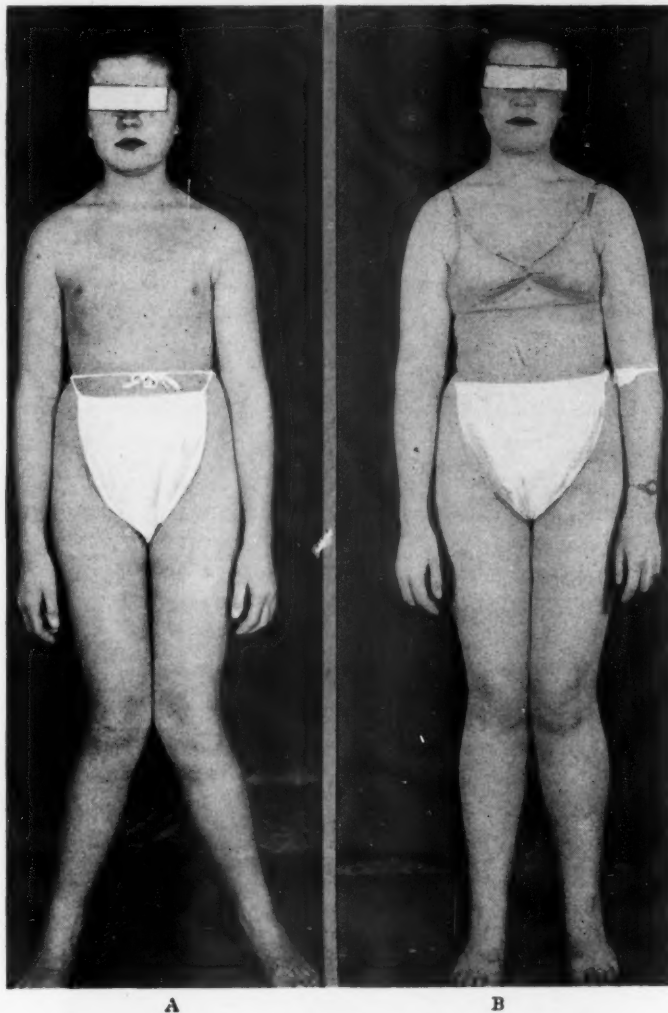


FIG. 11.—Case 5. A. Preoperative photograph, March, 1939.
B. Postoperative photograph, October, 1944.

It was presumed that an osteotomy would be necessary for the correction of the deformity of the knees. However, when the patient was seen for follow-up, November 11, 1939, the malleoli were already three inches closer. She stated that she was less nervous and did not tire as easily. She was not seen for five years. Follow-up letters were not answered, possibly because the patient and her father feared that the operation would be insisted upon. However, in October, 1944, she deemed it safe to return. A gratifying correction of the genu valgum had taken place (Fig. 11 B). Serum calcium, phosphorus and phosphatase were normal.

Case 6.—C. S., (311593), female, age 18, was admitted to the hospital, May 19, 1940, complaining of a lump in the neck and pain in the right hip. Inspection of the neck revealed an obvious nodule in the region of the right lobe of the thyroid (Fig. 14).

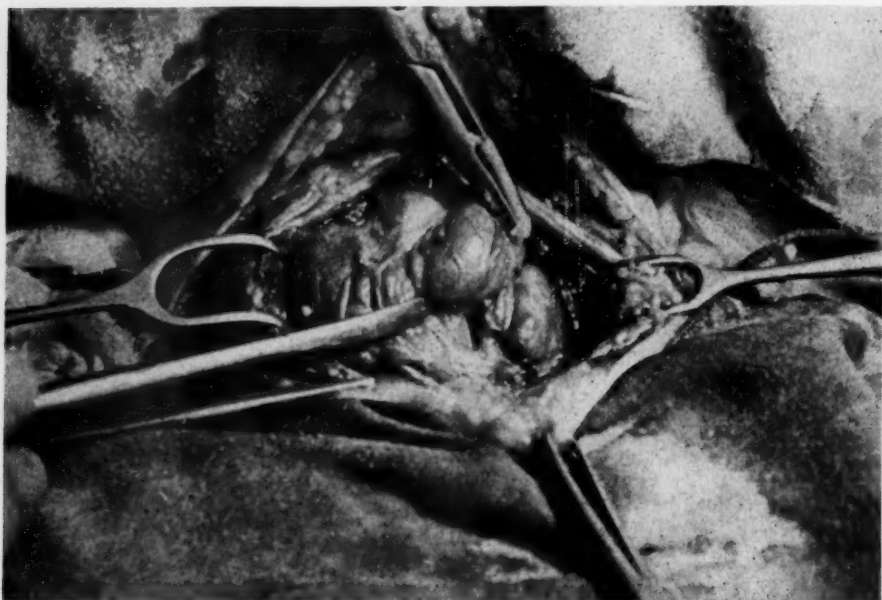


FIG. 12.—Photograph at operation (Case 5) showing parathyroid adenoma *in situ*, where it lay behind the lower pole of the left lobe of the thyroid.

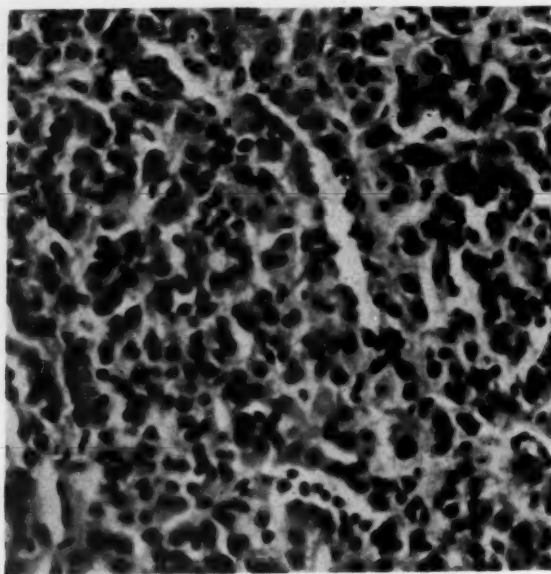


FIG. 13.—Photomicrograph of adenoma (Case 5).

Roentgenograms showed typical osteitis fibrosa cystica. On May 24, the serum calcium was 16.5 mg., phosphorus 2.9 mg., phosphatase 13 Bodansky units.

Operation.—May 28, 1940: No tumor could be found on the left side. On the right,

HYPERPARATHYROIDISM



FIG. 14.—Case 6, showing visible nodule in the neck.

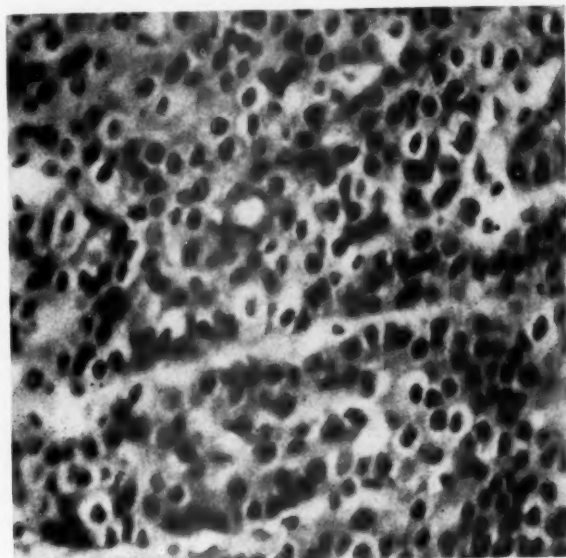


FIG. 15.—Photomicrograph of adenoma removed from Case 6.

there was a definite tumor which felt as though it were behind the thyroid gland, pressing up into it. The entire right lobe of the thyroid including this nodule was removed. The tumor proved to be a parathyroid adenoma of the chief cell type (Fig. 15).

Two days after the operation, the serum calcium was 6.9 mg., the phosphorus 3.22, and the phosphatase 3.2. She was given large doses of calcium and vitamin D. There was an increase in the serum calcium, and she was discharged on June 8. However, it was necessary to hospitalize her again on June 10 on account of the appearance of numbness and tingling of the fingers suggestive of impending tetany. After a week of calcium therapy, she was discharged. Follow-up in December, 1944, showed the patient to be asymptomatic. Progress roentgenograms revealed considerable recalcification of the bones. Serum calcium (not fasting) was 11 mg.

SUMMARY

Six cases of hyperparathyroidism have been reported. One patient did not have surgical intervention, and expired with the picture of acute parathyroid intoxication. Adenomata were removed from the other five patients. One of these died four months after operation in an hypoparathyroid state. The remaining four patients have been followed from eight to four years after operation, and appear to be normal individuals.

It is hoped that the report of this small series will serve as a reminder of the existence of the disease of hyperparathyroidism, and that it will encourage further reports of late results.

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DISCUSSION.—DR. FRANK H. LAHEY, Boston, Mass.: I think it is a very nice thing to have the subject of hyperparathyroidism brought up occasionally because I am sure that a great many parathyroid adenomas are being overlooked constantly.

I would always like to pay tribute to the group at the Massachusetts General Hospital, in Boston, who have done such fine work on parathyroids, and particularly to Doctor Fuller Albright.

I would particularly like to call attention to the danger of tetany in these patients with hyperparathyroidism who have had parathyroid adenomas removed. In the slides will be shown a large parathyroid adenoma (Fig. 1), removed from a patient with hyperparathyroidism about two weeks ago, and the calcium estimations morning and night

HYPERPARATHYROIDISM

immediately after operation (Fig. 2). It is of interest to note how rapidly the blood calcium can drop in 48 hours to half the point at which it was before operation. We must all realize that many of these patients with hyperparathyroidism, unless they are watched carefully, will go into tetany and will unnecessarily go through the emotional ordeal of this frightening episode. We must all realize that the overactive parathyroid adenoma largely takes over the function of the other parathyroid glands and so these patients require a few weeks before their remaining parathyroids resume their activities after the toxic adenoma has been removed. We have been extremely careful to protect these patients from tetany, who have had parathyroid adenomas removed, with administrations of calcium and A.T.-10 and to withdraw this medication gradually so that more and more load can be thrown upon the remaining parathyroid glands, and so that they will gradually resume their activities.

We have learned a good deal in our search for parathyroid adenomas about the locations where they can be found. One should never fail to release the upper pole of the thyroid by tying the superior thyroid artery and vein and pulling the upper portion of the thyroid away from the larynx because the upper parathyroid is so frequently behind the upper pole, and gets molded into the gland. We have reported three intrathyroid parathyroids found at this point.

Another thing which is of great assistance is to expose the inferior thyroid artery carefully and dissect it in a dry field from well down behind the common carotid up to its entrance into the gland, carefully preserving each branch. If a branch is found coming off the trunk and running toward the mediastinum, and this branch is followed down, it will often lead to a mediastinal adenoma or an adenoma in the areolar tissue beneath the clavicle.

I am sure we need to do more frequent blood calcium determinations in people with nerve root pressure symptoms, with muscle pains, with kidney calcification and renal stones, in order that we can discover parathyroid adenomas before these patients have reached the stage of osteitis fibrosa cystica or before spontaneous fractures have developed.

DR. HUGH A. GAMBLE, Greenville, Miss.: I want to emphasize the remarks of Doctor Lahey, that the disease is not as rare as we think. I am from a rural district and a small community, and I have seen two cases of this condition diagnosed preoperatively, with recovery in both cases.

There is another phase of the subject I would like to emphasize. I believe that the parathyroids have more to do with calcium metabolism than any other organs. We see a great many cases of postmenopausal osteoporosis of the spine in which there is decalcification of the spine and the spinal vertebrae become crushed. These patients suffer a great deal. Personally, I believe the parathyroids have much to do with this decalcification, and while the blood picture is not usually changed as much as we find in adenoma of the parathyroids, the blood calcium is usually elevated above normal and the phosphorus is lower than the average.

In three of these cases I have at operation demonstrated the parathyroids and removed half of them. Two patients were relieved entirely symptomatically and the progress of the disease was stopped. The third patient obtained no relief. I think, however, that a further study relative to the influence of the parathyroids upon postmenopausal osteoporosis of the spine is well worth emphasizing.

A few years ago Albright brought out a report of 42 cases of this condition in which he claimed that the pathologic changes present were always due to postmenopausal conditions. He reported only one case in this series of adenoma of the parathyroids. However, I am firmly convinced that the absorption of calcium in this condition is more influenced by the action of the parathyroids than in any other way, and I feel that these patients should be studied more carefully and our results in their treatment would no doubt be improved.

DR. THOMAS D. SPARROW, Charlotte, N. C.: Doctor McClure and Doctor Lam have given us a most interesting and instructive discussion of the end-results of the treatment of hyperparathyroidism. Perhaps the remarks that I am about to make are not germane to this discussion; however, it does concern the activity of the parathyroid gland and the result obtained in its removal.

Many authors have questioned whether or not the parathyroids are an etiologic factor in calcinosis universalis. Since in this condition there is a definite disturbance of the calcium metabolism, the finger of suspicion is at least pointed to the parathyroid glands. The fact that as a rule the blood calcium and phosphatase are normal in calcinosis universalis, would lead to the opinion that there is no active hyperparathyroidism in this disease.

Ramsdell has removed the parathyroid in several cases and has reported improvement of the condition; he suggests that this may be due to a dysfunction of the parathyroid rather than to an hyperparathyroidism.

My reason for entering this discussion is that recently we have had the opportunity of observing a case of calcinosis universalis in which the parathyroids were removed and in which there was a high blood calcium and a high phosphatase. I would like briefly to report the results obtained in this case:

On September 9, 1943, a boy, age 12, was admitted to the Orthopedic Service of the Charlotte Memorial Hospital, complaining of a swollen, tender right knee, and numerous nontender masses on both thighs, about the knees, elbows and in the axilla. These masses had been present for three months. The right knee had been very tender and painful for about one week. Three years prior to this admission, the patient had complained of severe pain in his back, and had become very weak and cachectic, with a considerable amount of muscular atrophy. There were numerous small, firm, ovoid and round masses palpable in the subcutaneous tissue about the elbow joints and in the axilla. Both thighs were swollen and fluctuation could be elicited above the knee. The right knee was very tender and painful. His temperature rose to 104° F. the next day. He was given sulfadiazine, and hot applications were applied to the painful right knee and thigh. On the ninth hospital day the right knee was aspirated and pus was obtained; it was incised and drained three days later. Thereafter, the temperature remained normal. On the 15th hospital day the left thigh was aspirated and about 400 cc. of a thick, white, milky-looking fluid was obtained which, on analysis, showed calcium 3.7 mg. per 100 cc., protein 7.8 mg. per 100 cc., and cholesterol 200 mg. per 100 cc.

A pathologic study of a biopsy on one of the masses near the elbow showed it to be a calcium granuloma. The roentgenologic examination led to the diagnosis of calcinosis universalis. This diagnosis was questioned when it was known that there was a high blood calcium and a high phosphatase present. The tests were checked and rechecked and run against normal controls, and proved to be correct readings. Because of the high blood calcium and high blood phosphates it was decided to perform a parathyroidectomy.

Under general anesthesia, two parathyroid bodies were identified and removed. Histologic examination proved the tissue to be parathyroid bodies.

The laboratory findings were as follows:

Date	Calcium	Phosphorus	Phosphatase	Sulkowitch Test
9-13-43	17.6 mg. %	4.3 mg. %	9.8 units	
9-15-43				Markedly positive
9-17-43	16.9 mg. %	4.1 mg. %	9.0 units	Markedly positive
9-27-43	16.2 mg. %	4.1 mg. %		
10-11-43	15.1 mg. %	4.0 mg. %	9.6 units	Markedly positive
REMOVAL OF PARATHYROID GLANDS				
10-20-43	14.8 mg. %	4.0 mg. %	9.1 units	
10-26-43	15.0 mg. %	4.4 mg. %	8.3 units	
11-27-43	12.7 mg. %	4.0 mg. %	6.6 units	Negative
1-3-44	13.0 mg. %	4.2 mg. %	5.0 units	Negative
2-21-44	14.2 mg. %	3.8 mg. %	5.0 units	Negative
4-10-44	11.7 mg. %	3.8 mg. %	4.5 units	Negative
8-10-44	10.8 mg. %	3.3 mg. %	3.8 units	Negative
10-9-44	16.0 mg. %	4.0 mg. %	2.1 units	Negative

1. This case is reported as a case of calcinosis universalis in which there was a high blood calcium and high phosphatase.

2. The removal of the parathyroids resulted in a marked clinical improvement and lowering of the phosphatase (Bodansky units.)

HYPERPARATHYROIDISM

3. Parathyroidectomy resulted in reducing of the calcium excretion in the urine. Whether or not it had any effect on the blood calcium is questionable.

DR. JOHN DEJ. PEMBERTON, Rochester, Minn.: I want to say a word regarding the incidence of this disease, and express my conviction that it is much higher than is generally supposed. Doctor Lam spoke of our series of 15 cases which we had observed up to few years ago. About two years ago, one of my colleagues, Doctor Keating, spent six months in Boston at the Massachusetts General Hospital with Doctor Albright and his associates, and since his return we have seen as many cases of hyperparathyroidism in the Mayo Clinic as we saw in the ten preceding years.



FIG. 1

DR. ROY D. MCCLURE, Detroit, Mich. (closing): We were keenly disappointed in the end-result of our second case. This was the patient who expired four months after operation, with the typical signs of parathyroid insufficiency. The difficulties of dealing with such a situation, and the feeling of helplessness which one has, cannot be stressed too strongly. The case was discussed with Doctor Churchill and it was agreed that it is advisable to carry out partial resection of certain of the larger adenomas followed by a second stage if necessary.

More frequent diagnoses of the condition may be expected when doctors are well informed of the signs and symptoms and are on the lookout for them. Urologists, in particular, are in an excellent position to spot the cases.

HYPERPARATHYROIDISM COURSE OF BLOOD CALCIUM AFTER OPERATION

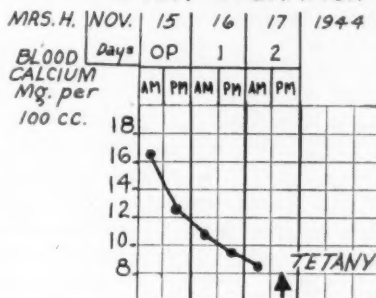


FIG. 2

CASES OF SEVERE PELVIC INJURY*

LT. COL. LLOYD G. LEWIS, M.C.

WASHINGTON, D. C.

PELVIC INJURIES are frequently complicated by wounds of the urethra, bladder and ureters, which require immediate diagnosis and prompt surgical treatment.

Diagnosis must be made by evaluation of clinical signs. Symptoms lack specific reference. Systematic observation for wounds of entrance and exit, ecchymosis, swelling; palpation of tissues for extravasation of blood or urine; rectal or vaginal examination and the use of the diagnostic catheter will usually establish the diagnosis. Cysto-urethrography, cystoscopy and cystometry may supply confirmatory evidence, are usually not required, and may be contraindicated.

When the diagnosis of rupture of the urethra, bladder or ureter is in doubt, drain, divert the urinary stream, control bleeding, and repair the defect if practicable. The scalpel is still the safest instrument in urologic emergencies.

The following case reports are of patients wounded or injured on far-flung battle fronts, who received their first treatment in emergency stations and evacuation hospitals. The fact that they are alive is evidence of the effectiveness of their initial treatment. It would seem profitable to critically evaluate their surgery in respect to the four cardinal principles involved—drainage for extravasation, diversion of the urinary stream, hemostasis, and repair of the defect.

Case 1.—A 26-year-old soldier, wounded on April 23, 1943, by a machine-gun bullet, had the wound of entrance just above the left greater trochanter; the wound of exit six centimeters above the right trochanter. The missile perforated the rectum, the urinary bladder, and injured the right sciatic nerve. Débridement of the wounds was carried out. At celiotomy, two sigmoid perforations and one of the ileum were sutured; two bladder perforations were closed, and the urine was diverted by cystostomy. He was transferred to an evacuation hospital and then to a station hospital where the suprapubic tube was removed on May 10, 1943. Following removal to a general hospital on May 14, 1943, he developed intestinal obstruction, and the diagnosis of vesico-enteric fistula was made. The suprapubic tube was reinserted and a transverse colostomy was performed. He was transferred to the Zone of the Interior and was admitted to Walter Reed General Hospital on September 16, 1943. Urine was draining through the cystostomy and from the wound over the right hip. He had a foot-drop on the right but the major part of the sciatic nerve was uninjured. The colostomy was functioning well. The vesico-enteric fistula had apparently healed. Intravenous urograms showed a moderate right hydronephrosis, with dilatation of the ureter down to a point near the bladder. A roentgenogram taken after injection of diodrast through an ureteral catheter passed through the sinus tract near the right greater trochanter, showed the right ureter dilated below an obstruction at the brim of the true pelvis.

* Read before the Fifty-sixth Annual Session, Southern Surgical Association, December 5-7, 1944, Hot Springs, Va.

SEVERE PELVIC INJURY

There was calcification to the right of the bladder, due to deposition of urine salts (Fig. 1).

On September 12, 1943, five months after injury, right ureterocystoneostomy was performed through a right lower quadrant muscle-cutting incision. The ureter was readily exposed on the surface of the peritoneum and freed to the scar near the bladder. The cut end of the ureter was dissected from the fistulous tract which communicated with the wound in the right hip. Anastomosis was carried out by a method very similar to the usual technic of ureterosigmoidostomy. The bladder was perforated with an

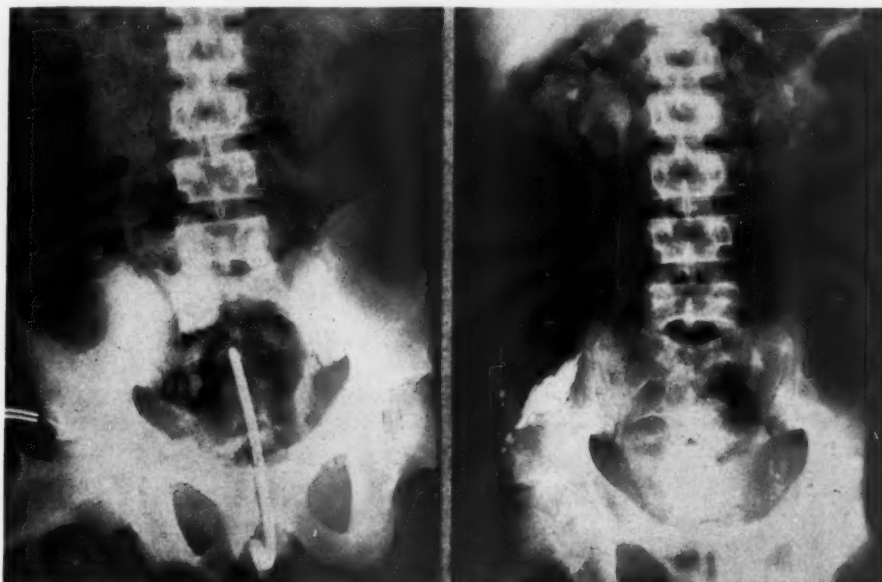


FIG. 1

FIG. 2

FIG. 1.—Case 1: Preoperative roentgenogram showing urethral catheter in place; calcification in a fistulous tract behind the ureteral bladder, the bladder itself distended with air. An ureteral catheter is shown passing through the fistulous tract above the right trochanter. The lower portion of the right ureter is dilated with contrast media injected through the ureteral catheter.

FIG. 2.—Case 1: Postoperative excretory urogram showing excellent function of both kidneys. The bladder is irregular in shape, distended with iodide. Lipiodol is noted in the fistulous tract in front of the right ilium.

Halsted clamp at a point of fixation to the scar. A mattress suture of No. 1 chromic catgut was placed through the tip of the ureter which had been cut obliquely; the two ends of the suture were placed on two curved needles, passed through the cystostomy opening together and brought out three centimeters below the perforation to fix three centimeters of ureter inside the bladder. Three chromic catgut sutures were used to fasten the ureteral wall to the outer bladder wall. The wound was closed with drainage.

Intravenous urograms six weeks after operation showed that the hydronephrosis had been relieved and the kidney was functioning normally (Fig. 2). On December 3, 1943, the wounds of the hips which communicated with each other and with the old suprapubic wound were curetted, and large amounts of scar tissue and calcified material were excised. The bladder wounds had healed, and the patient was voiding all of his urine through the urethra. On January 4, 1944, the colostomy was closed.

DISCUSSION.—Critical evaluation of this case shows that the diagnosis of rupture of the right ureter was not made, because of inadequate exposure and drainage of the perforation on the right side of the bladder. Diversion of

urine from the bladder was adequate but due to diagnostic difficulty urine from the right kidney was allowed to drain through the débrided wound of the right thigh. Hemorrhage was controlled. Ureterocystoneostomy at the time of exploration would have prevented the formation of a fistula and also the deposition of calculus in the extravasated wound. The patient has made a satisfactory recovery after four major operative procedures.

Case 2.—A 2nd Lt., A.N.C., was injured when a "jeep" in which she was riding overturned on August 19, 1944. She suffered fracture of the pelvis with remarkable separation of the symphysis, fracture of the right pubis into the acetabulum, with dislocation of the right hip. She was taken to a station hospital in severe shock, received morphine and plasma. She was placed in a plaster encasement temporarily because the dislocation of the right hip could not be reduced. After passage of a diagnostic catheter and draining 200 cc. of blood from the bladder, 100 cc. of skiodan was injected, and roentgenograms taken. These films were read as showing no evidence of extravasation; however, review of these films definitely indicates intraperitoneal extravasation of iodide (Fig. 3). Because of negative roentgenographic evidence her bladder was not drained, in spite of positive signs of hematuria and perivesical mass felt by vaginal examination.

On the second day after injury cystoscopy was carried out and definite evidence of rupture was seen of the posterior wall of the bladder. Another cystogram was done which was also read as negative. Review of this film, again, shows peritoneal extravasation (Fig. 4). The patient remained in a state of shock; there was extraordinary distention; peristalsis was absent, there was tenderness around the umbilicus; the patient was considered in too poor shape to stand surgery. She had a severe chill. Supportive treatment was continued.

On the third day after injury, suprapubic incision was made and extravasation of urine and blood found around the bladder and in the peritoneal cavity. Cystostomy was performed, fluid was evacuated from the peritoneal cavity, and perivesical drains placed. She had a good deal of fever for two weeks. Penicillin was administered. The cystostomy tube was removed on the 12th day and an urethral catheter placed.

Twenty-three days after injury it was noted that there was edema and induration about the right vulva. She was transferred to a General hospital where reduction of the hip was carried out under general anesthesia and a new spica applied.

On arrival at Walter Reed General Hospital on October 14, 1944, patient was wearing a hip spica, the hip dislocation had been reduced, the right pubic bone was in better position, but there was still marked dislocation at the acetabulum and wide separation of the symphysis pubis. The suprapubic wound had healed. She was suffering from severe pain on urination, referred to the left hip. There was gross pyuria.

Excretory urograms showed normal kidneys and ureters. The bladder was ovoid. On urination, iodide seemed to pass in the vulva tissues to the right of the bladder (Fig. 5). The perivesical abscess produced by the extravasation finally pointed in the right vulva and was drained. The tract communicated from the perivesical space through the tissues behind the fractured pubis with the incision in the right vulva. Following this drainage the patient's temperature returned to normal and her condition rapidly improved. The bladder wound healed first, followed by the drainage tract behind the dislocated pubic bone.

DISCUSSION.—The critical condition of the patient at the time of injury made surgical treatment hazardous. However, her condition did not improve by delay in initiating treatment for a ruptured bladder in order to obtain confirmatory evidence of rupture. Drainage of the prevesical extravas-

SEVERE PELVIC INJURY

FIG. 3



FIG. 4



FIG. 5

FIG. 3.—Case 2: Cystogram taken at the time of injury, showing well-filled bladder and extravasation of iodide into the perineum in the pelvis.

FIG. 4.—Case 2: Cystogram taken two days after injury, showing partially distended bladder and iodide free in the peritoneal cavity. Dislocation of the right hip, fracture of the right pubic bone into the acetabulum, and wide separation of the symphysis pubis are noted.

FIG. 5.—Case 2: Urethrogram taken during voiding. The pear-shaped bladder is slightly irregular on the right side. The urethral orifice is open and extravasation of iodide can be seen behind the right pubic bone, extending into the right vulva.

ation was inadequate. Diversion of urine was accomplished, hemostasis obtained, and the defect in the bladder which communicated with the peritoneum was sutured. The use of penicillin probably did have profound effect upon her peritonitis and perivesical infection. It did serve to wall off the prevesical abscess, which pointed and was drained seven days after penicillin was discontinued.

Case 3.—A 27-year-old sergeant in the infantry, while on duty in the Southwest Pacific, suffered a crushing injury of the pelvis, amputation of his left leg at the thigh, severe crushing injury of the abdominal contents, and rupture of the bladder and membranous urethra, when an ammunition truck overturned. The patient was treated effectively for shock; his leg was amputated by the guillotine method; his bladder was drained suprapubically and he was sent to the nearest evacuation hospital. There an attempt was made to unite the ends of the urethra by passage of a catheter after sounds passed antegrade and retrograde had met in the region of the prostatic apex. With this catheter in place cystostomy drainage was maintained for some time, but when the suprapubic tube was removed no drainage of urine occurred through the urethral catheter.

The patient was admitted to Walter Reed General Hospital, three months after his initial injury, wearing a suprapubic tube. The urethral catheter was in place but drained no urine. On his arrival the cystostomy wound was dilated to allow introduction of the examining finger into the bladder. The urethral catheter did not pass through the prostatic urethra but entered the suprapubic wound through the space of Retzius. Roentgenograms showed the catheter to pass to the left of the midline, and to lay lateral to the prostate where it could be palpated by rectum.

Under sodium pentothal anesthesia, cystoscopy was carried out by passing the panendoscope through the cystostomy opening. Filiforms and catheters were admitted through the vesical orifice but would not pass for more than two centimeters. The cystoscope was removed and an attempt was made to pass sounds through the prostatic urethra retrograde to meet a sound passed antegrade. This maneuver failed.

On July 20, 1944, the operation, as described by Young, was undertaken through the perineum. There was no difficulty in anastomosing the prostatic apex with the torn end of the membranous urethra. Drainage was established in the prevesical space, from which considerable granulation tissue was curetted. A No. 24 Foley bag catheter was used as an urethral splint.

Nine days after operation a periurethral abscess at the penoscrotal juncture was drained. On the 10th day a severe secondary hemorrhage occurred which required packing of the prevesical space and the perineum. At that time the sutures in the perineum had sloughed out and there was a two-centimeter defect in the urethra at the prostatic apex. This was resutured on the 18th day, when there was slight hemorrhage from the perineum. Traction was made on the Foley bag to relieve strain on the suture line.

Twenty-three days after operation the patient had another severe hemorrhage which required opening of the suprapubic wound, packing of the prevesical space, and packing of the perineum and the area of the periurethral abscess. There was severe sepsis of the entire wound. To obtain hemostasis the defective membranous urethra was again sutured. Severe secondary hemorrhage again occurred on the 37th day, after two weeks of cessation of all bleeding, and required packing of the entire area in front of the prostate and urethra.

DISCUSSION.—The patient had adequate drainage, diversion of the urinary stream, and hemostasis. Repair was not immediately undertaken because of

SEVERE PELVIC INJURY

the precarious condition of the patient. Later attempted establishment of urethral continuity was unsuccessful. A false passage was established. It seems probable that perineal repair of the defect was undertaken too soon after removal of the catheter from the false passage. Secondary hemorrhage is a serious complication in many of our severely wounded. Scar, infection, and a debilitated patient are a poor surgical combination. Recently we have been able to satisfactorily repair the defects.

Case 4.—A 40-year-old gunner of a B-17 bomber was struck by a 20-mm. cannon shell, September 27, 1943. Major Herbert Willey Meyer's notes are quoted: "There is a large wound of the anteromedial aspect of the left thigh extending from 10 cm. above the knee to the inguinal region, damaging and destroying the muscles of the thigh, the abductor group and the sartorius. The femoral vessels are exposed from Poupart's ligament to the midthigh but are still in their sheath. The skin of the left scrotum is destroyed; the left testicle practically destroyed. The right scrotum is intact. The perineum is extensively damaged. There is a strand of tissue, eight centimeters long and one centimeter wide, attached to the Corpora of the penis and showing some urethral mucosa. The entire urethra is divided from the exposed prostate in the bulbous portion of the corpus spongiosum. The entire perineal body is destroyed. The skin around the anus is completely avulsed from the anal canal. There is a wound of the right buttock continuous with the perineal wound, from which there is a steady oozing of blood. This wound leads along the descending ramus of the pubis and ischium to the posterior aspect of the neck of the femur where a large metallic foreign body can be felt. The inferior pubic ramus and the ischium are fractured. Many loose pieces of bone are in the tract."

A rapid colostomy was performed through a McBurney incision. The peritoneum was not sutured. A rubber catheter was placed under the loop for support and the external oblique fascia was closed above and below the loop. Suprapubic cystostomy was performed. The wound of the left thigh was excised. The left testicle was removed and the scrotum débrided. The perineum was débrided and a No. 14 F. catheter was placed through the urethra. The wound of the right buttock was débrided. Penicillin therapy was instituted and later the wound of the left thigh was grafted.

This patient was evacuated to the Zone of the Interior and was admitted to Walter Reed General Hospital February 27, 1944.

On March 30 plastic repair of the urethra was undertaken. With the patient in the lithotomy position it was impossible to abduct the left thigh because of scar formation above the grafted area. Relaxing incisions were made in the scar at the left groin so that exposure of the perineum was effected. A sound passed through the anterior urethra was obstructed just behind the penoscrotal juncture. Incision was made over the tip of the sound. By dissecting around the urethra it was possible to bring the penis and urethra backward about three centimeters. Filiforms and followers entered the bladder through the prostatic urethra. By means of an inverted U-incision the rectum was brought forward to its normal position in the perineum. By exploring in the wound of the right buttock, mucous membrane was discovered and turned to cover the remaining defect in the urethral bulb. A large shift of the skin of the right buttock was utilized to cover the newly made urethra. This procedure left a sizeable defect over the buttock behind the ischium. There remained a large defect in the region of the left scrotum. These were covered with petrolatum gauze. A No. 26 Foley bag catheter was used as a splint for the urethra. The cystostomy was left open, with a No. 32 Malecot catheter in place.

A small urethral perineal fistula persisted for six weeks and finally healed. The only complication was the formation of two calculi in the urethra (Fig. 6). One was removed

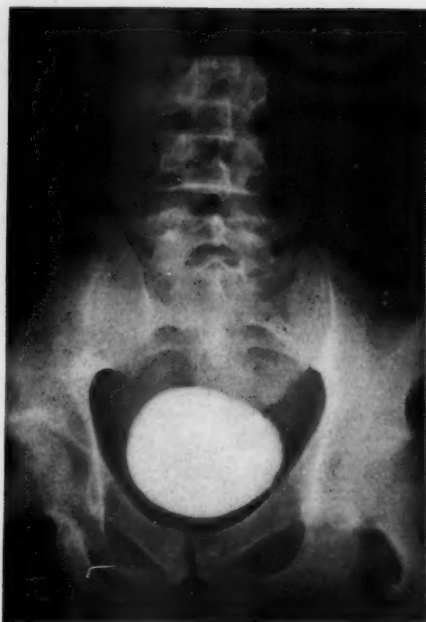


FIG. 6



FIG. 7

FIG. 6.—Case 4: Cystogram showing perfectly normal bladder and closed vesical orifice. There is marked dislocation of the fragment of ischium. A calculus may be seen in the bulbous urethra.

FIG. 7.—Case 4: Postoperative cysto-urethrogram during voiding. The posterior urethra and bulbous urethra are filled with iodide. Note that the normal constriction at the external upper sphincter is lacking.



FIG. 8



FIG. 9

FIG. 8.—Case 4: Postoperative result after urethroplasty, showing grafting scar of the left thigh, well-healed suprapubic wound, and closed colostomy wound.

FIG. 9.—Case 4: Postoperative result after urethroplasty, showing scar of the right buttock, perineum and left thigh. The left scrotum has been resected. Wounds are well-healed. Patient's bladder and bowel control are perfect.

SEVERE PELVIC INJURY

through the fistulous opening; and the other was removed by means of ureteral stone forceps, through the anterior urethra (Figs. 7, 8 and 9). After the urethra had completely healed and the patient was voiding normally, the colostomy was closed. The urethra has been dilated to No. 26 F.

DISCUSSION.—Extravasation was prevented and diversion of the urinary stream accomplished by early cystostomy. Hemostasis, a serious problem, was controlled by sutures and packing. Repair of a large defect in the urethra was accomplished after sufficient time had been allowed for wound healing and contracture of scar. Conservative emergency surgery and the use of every available tissue has enabled us to gain a very satisfactory result. It should be noted that in spite of loss of external sphincter and practically all of the perineal and bulbar musculature, normal urination is reestablished.

CONCLUSIONS

The soundness of the four surgical principles for treatment of ruptures of the bladder, urethra and ureter, is established. Drainage for the prevention of or treatment of existing extravasation is immediately imperative to save life and lessen morbidity. Diversion of urine is essential. Hemostasis in severe war wounds may be a serious problem. Repair of defects is desirable at the time of initial surgery, to allow healing with minimum scar formation. If repair is impracticable at the time of injury, sufficient time should be allowed for healing, scar contracture, subsidence of infection and for rehabilitation of the patient, before definitive surgery is undertaken. Several patients with severe pelvic injury, complicated by rupture of the bladder and membranous urethra, who had repair of defects performed at the time of injury, have been observed by us and the results have been extremely satisfactory. We have also carried out perineal repair of the ruptured membranous urethra on seven patients who had had drainage and cystostomy, in whom it was impracticable to carry out repair at the time of injury, with satisfactory results. It should be pointed out, however, that delayed repair results in more scar formation. Therefore, early repair is preferable whenever possible.

STUDIES ON TRAUMATIC SHOCK:

V—THE TREATMENT OF CLINICAL SHOCK WITH GELATIN*

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EVEN before the outbreak of the present war, considerable interest had developed in blood substitutes, other than plasma or serum albumin, for the treatment of traumatic shock; among the list of materials suggested for this use was gelatin.

The pertinent literature on this subject, has been reviewed thoroughly in two excellent papers which have appeared recently from the University of Pennsylvania Surgical Clinic.^{1,2} Studies carried out by these workers have shown that specially prepared ossein gelatin can be given intravenously to human patients without fear of adverse pyrogenic, antigenic, hepatic or renal reaction. A rather large clinical experience during the past three years has increased our desire, and confirmed our impression, of the need for a useful substitute for plasma or albumin in the treatment of clinical shock. After conversations with Doctors Lockwood and Koop, we undertook to treat with gelatin infusions a number of patients suffering from shock due to trauma, blood loss, or extensive burns.

The present communication, therefore, is concerned with the effectiveness of gelatin in the treatment of 67 patients in shock because of trauma to the extremities, chest and abdomen, and 28 severely burned patients, where gelatin has been used almost solely as the initial intravenous therapy fluid. Illustrative case reports are given for each different group of patients.

MATERIALS AND METHODS

Gelatin for intravenous use is prepared by hydrolysis, enzymatic or chemical; if certain well defined precautions are observed in its preparation, a product of rather unusual uniformity as regards viscosity and molecular homogeneity can be obtained. Through the cooperation of the Blood Substitutes Committee of the National Research Council and the gelatin industry, a considerable body of evidence on the physicochemical properties of gelatin has been obtained in the past two years. These studies have made it clear that for intravenous use not "any" gelatin solution will suffice. For this reason, the Food and Drug Administration has laid

* This study was carried out under a contract, recommended by the Committee on Medical Research, between the Office of Scientific Research and Development and the Medical College of Virginia.

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GELATIN IN SHOCK

down specific requirements for gelatin solutions when they can be made available for general use.

The molecular weight of gelatin varies according to the amount of degradation it has suffered in its preparation. Whereas serum albumin has a molecular weight of about 69,000, that of "lightly degraded" gelatin is around 35,000, and "heavily degraded," about 20,000.

The effectiveness of any plasma substitute in the treatment of shock naturally depends to a large extent on the time it remains in the blood stream, and this is dependent on molecular size. Dr. D. Tourtelotte* supplied us with two types of gelatin solution, the "lightly" and "heavily degraded" (designated as P-20 and P-180). The first preparation had been degraded by autoclave treatment at 15 pounds for 20 minutes (P-20), and the second by autoclave treatment for 180 minutes (P-180).

TABLE I
RETENTION OF GELATIN P-20
"Lightly Degraded"

Name	Hour	Plasma Volume Cc.	Hematocrit	Protein Conc. %	Total Circulating Protein Gm.	Gain Protein Gm.	Notes
A. W.	0	2099	48	6.8	143		Given 1000 cc. P-20 6.0% gelatin (60 grams)
	4	3214	41	6.6	212	+69	
	8	3189	42	6.7	214	+73	
E. L.	0	2539	50	7.5	189		Given 1000 cc. 6.0% P-20 gelatin (60 grams)
	4	3620	44	7.2	261	+72	
	8	3833	45	7.2	277	+88	

CLINICAL SHOCK OBSERVATIONS

Gelatin has been given to 67 patients in moderate or severe shock due to the various causes listed in Table III. The "acute blood loss" group includes those patients who have suffered lacerations of large vessels from knife or razor wounds, with subsequent loss of large amounts of blood. The "chest injury" group is made up of patients in shock from penetrating wounds of the chest, causing injury to such vessels as the intercostal and internal mammary arteries, pulmonary vessels, and three patients with stab wounds of the heart. The "abdominal injury" group comprises those patients who have suffered stab and gunshot wounds of the abdomen, or a ruptured viscus from direct trauma; in the "skeletal trauma" group are patients in shock from simple and/or compound fractures of the long bones or pelvis, or traumatic amputations of the lower extremities. Blood volume determinations and hematocrit estimations were made on many of these shock patients. That shock was due in the main to the decreased circulating blood volume

* We are grateful to Dr. D. Tourtelotte and the Chas. B. Knox Gelatin Company for liberal supplies of these solutions for clinical treatment.

(usually 30-40 per cent) was borne out by these laboratory investigations and also by the recovery from the serous cavities of large quantities of whole blood in many of the operated cases. We have been conducting, therefore, a clinical study of the efficacy of one particular gelatin solution in the alleviation of clinical shock of the type that is most important and interesting to practicing surgeons, civilian and military.

From each of these groups of shock patients has been selected a representative case. In the accompanying clinical record and clinical charts is shown the response of these shock patients to intravenously infused gelatin, usually in 500-1000 cc. amounts.

TABLE II
RETENTION OF GELATIN P-180
"Heavily Degraded"

Name	Hour	Plasma Volume Cc.	Hematocrit	Protein Conc. %	Total Circulating Protein Gm.	Gain Protein Gm.	Notes
C. C.	0	2075	44	7.1	147		Given 1000 cc. 6% P-180 gelatin (60 grams)
	4	2343	42	6.6	155	+8	
	8	2102	44	6.9	145	-2	
W. M.	0	2295	41	8.3	191		Given 1000 cc. 6% P-180 gelatin (60 grams)
	4	2730	37	7.5	205	+14	
	8	2150	42	7.8	168	-23	

Initially, each of these gelatin preparations were given intravenously to four convalescent patients, and their disappearance rates followed by the determination of plasma volume before, and at intervals after, the rapid infusion of 1000 cc. of a six-per cent gelatin solution in 0.85 per cent saline. From Tables I and II it can readily be seen that the heavily degraded gelatin leaves the blood rapidly, while in contrast, in the normal patient, most of the lightly degraded gelatin is still present in the blood stream at the eighth hour after rapid infusion. Similar retention of lightly degraded gelatin was noted in the studies of Parkins, *et al.*¹ On the basis of these preliminary studies, we selected the less degraded gelatin for further clinical studies; in this paper is reported our experience in clinical shock from the use of this particular gelatin preparation.

It has been our practice generally to give gelatin infusions (as well as plasma or whole blood) by the "rapid syringe technic" which employs a small syringe attached to the tubing set-up by a three-way stop cock (Fig. 1). Only by this technic has our shock group found it possible to restore rapidly and adequately the circulating blood volume of many severely shocked patients. We are certain that some lives have been saved by this method of rapid infusion that otherwise would have been lost if more time-consuming infusion technics had been used.

GELATIN IN SHOCK

ACUTE BLOOD LOSS

Case 1 (Fig. 2).—*Diagnosis:* Multiple lacerations of face and scalp; including left temporal artery, hemorrhagic shock.

B. D., a 42-year-old white male, was admitted to hospital, February 6, 1944, after an automobile accident. When taken from car by the ambulance surgeon he was bleeding

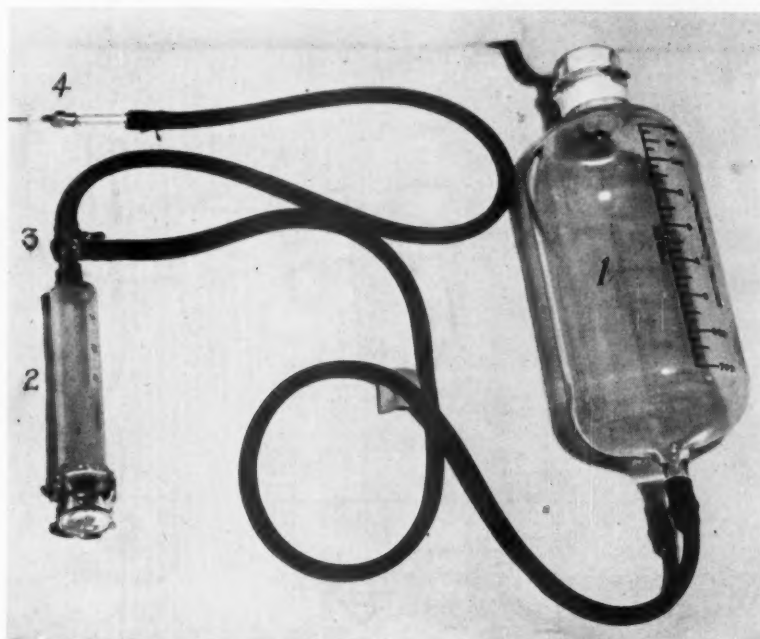


FIG. 1.—Set-up for rapid intravenous infusions for use with whole blood, gelatin, or plasma.

1. An ordinary 750 cc. bottle; 2. a 10 or 20 cc. Luer-Lok syringe. These size syringes are much more efficient for rapid infusion than the longer 50 cc. size; 3. A three-way stop-cock; a 16- or 18- gauge needle.

Our shock group has experimented with practically all types of equipment designed for infusing fluids rapidly in shock, and have found the set-up herein described by far the most efficient.

profusely from long lacerations of the left face and scalp, especially from a severed temporal artery. On admission to emergency room, the blood pressure was 60/40, pulse 72, respiration 26. Patient was not alcoholic. Initial hematocrit 40 per cent. An immediate rapid infusion of 1000 cc. gelatin solution restored the blood pressure to

TABLE III
SHOCK PATIENTS TREATED WITH GELATIN

	No. of Cases
Acute blood loss.....	15
Chest injury.....	14
Abdominal injury.....	10
Skeletal trauma.....	28
Severe burns.....	28

110/70 and then to 170/80. The hematocrit at the end of two hours was 32 per cent. After suturing of wounds and four days' hospitalization, recovery was complete except for a secondary anemia (Hb. 72 per cent).

Case 2 (Fig. 3).—*Diagnosis:* Gunshot wound of left groin; severance of left femoral artery; severe hemorrhagic shock. *Operation:* Ligation of left femoral artery and vein; gelatin infusion for shock.

Acute Blood Loss

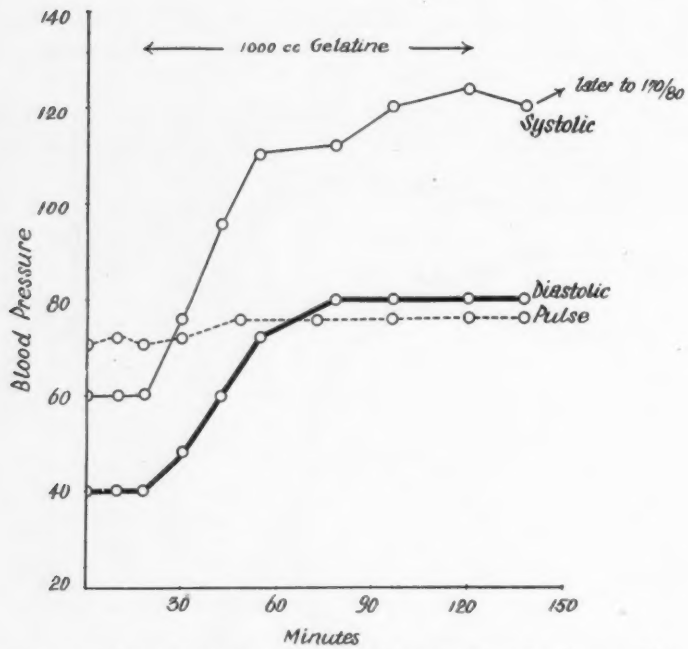


FIG. 2.—Clinical effects of gelatin infusion in acute blood loss from multiple lacerations.

Gun Shot Wound of Artery

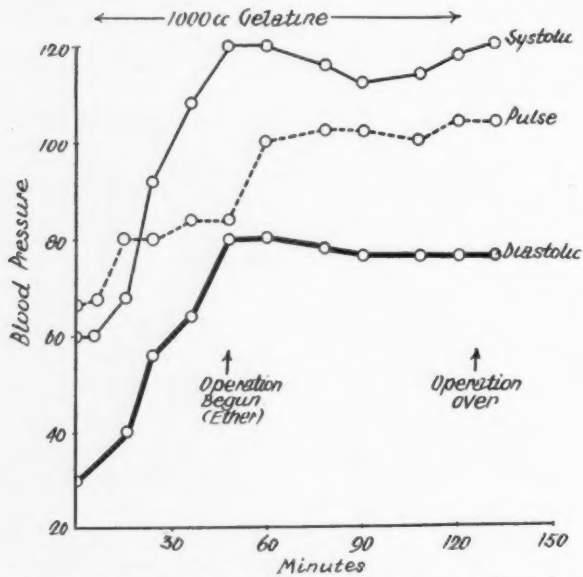


FIG. 3.—Clinical effects of gelatin infusions in acute blood loss from a severed femoral artery.

GELATIN IN SHOCK

G. F., a 50-year-old colored male, was shot at close range with a 32-caliber revolver. On admission to St. Phillips Hospital emergency room, the patient's blood pressure was 60/30, pulse 65, extremities cool and dry, no sweating, venous filling fair. Plasma volume estimation—32 cc./Kg., hematocrit 41 per cent, representing loss of 1400 cc. whole blood. There was a bullet wound immediately over the femoral artery

STAB WOUND OF HEART

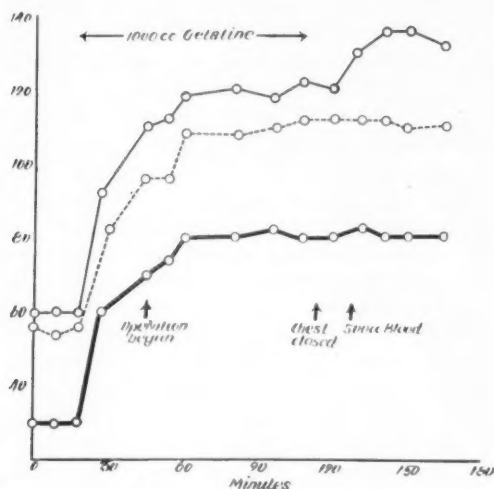


FIG. 4.—Clinical effects of gelatin infusions in a patient with stab wound of right auricle.

Stab Wound of Chest

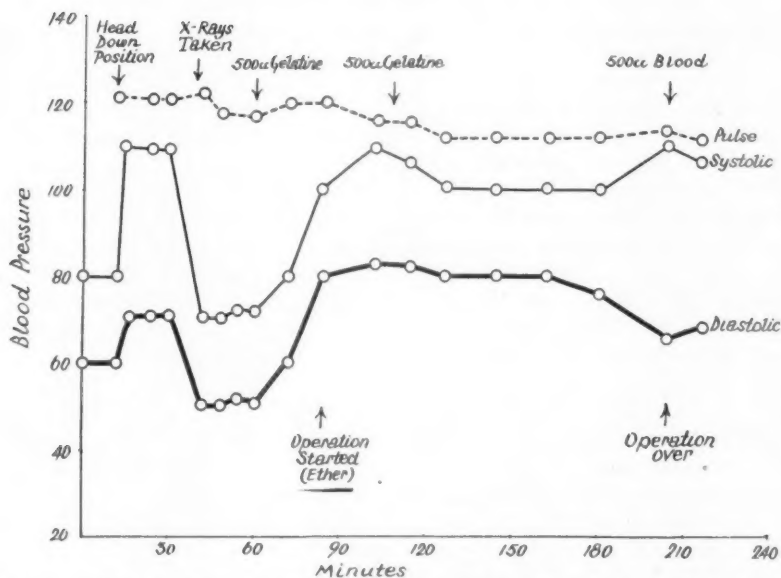


FIG. 5.—Clinical effects of gelatin infusions in a patient with stab wound of the chest, severing an internal mammary artery.

at Poupart's ligament, with no pulsation below of this or the popliteal artery. A rapid infusion of gelatin restored the blood pressure to 120/80, and this was maintained during the operation that followed by the infusion of another 500 cc. gelatin solution. A transfusion of 500 cc. whole blood was given after the operation to combat anemia. (Hemoglobin had fallen to 62 per cent). Two novocaine lumbar sympathetic blocks were carried out during the night, and despite the fact that the continuity of the artery could not be restored, the patient made a good recovery.

Figure 3 shows the effect of gelatin infusions in this shock patient.

CHEST INJURY

Case 3 (Fig. 4).—*Diagnosis:* Stab wound of right auricle; "sucking" hemopneumothorax; secondary shock. *Operation:* Cardiorrhaphy.

V. S., a 28-year-old colored female, had been stabbed in the right chest while asleep in bed. On admission to the St. Phillips Hospital not long after, she was in a state of profound shock, blood pressure 60/30, extremities cool and dry, pulse 56, of extremely poor volume at the wrist. There was a stab wound 2 cm. in length in the second right interspace, 1 cm from the sternal border. A diagnosis of stab wound of the heart or severance of the right internal mammary artery was made. Plasma volume was 35 cc. Kg.; hematocrit 37 per cent. Patient was prepared for operation and given by rapid infusion 500 cc. gelatin solution. After 300 or 400 cc. had been given the blood pressure rose to 110/70, pulse 90. Patient was taken to operating room, where a second 500 cc. gelatin infusion was started. At operation, a large amount of blood was found in the right pleural cavity, coming from a 1-cm. stab wound of the right auricle through a rent in the pericardium. This was closed with some difficulty because of the friable nature of the tissue, but the patient withstood the operation quite well, as can be seen from Figure 4. Nine hundred cubic centimeters of whole blood was collected from the right pleural cavity and given to the patient by autotransfusion.

Case 4 (Fig. 5).—*Diagnosis:* Stab wound of the left chest; severance of left internal mammary artery; hemorrhagic shock. *Operation:* Exploratory thoracotomy; ligation of left internal mammary artery and vein; gelatin infusion.

J. J., a 22-year-old colored male, had been stabbed in the left chest one hour before admission. On entry, he was in moderate shock, blood pressure 80/60, extremities cold and dry, pulse 76. When placed in the Trendelenburg position, blood pressure rose to 110/70. There was a 2-cm. stab wound in the left second interspace in the parasternal line. A diagnosis of severed internal mammary artery was made and patient taken to the operating room. On arrival there, due to the fact the patient had been allowed to raise his head, his blood pressure had fallen to 70/50. Five hundred cubic centimeters of gelatin solution was given rapidly and the pressure rose to 100/80, and the operation was started while the second 500 cc. of gelatin solution was being given slowly. At operation, about 1500 cc. whole blood was found in the left pleural cavity, coming from a severed left internal mammary artery, which was ligated. No other intrathoracic injury was found. Figure 5 shows the response of this patient to 1000 cc. gelatin infusion. Five hundred cubic centimeters of whole blood was given by autotransfusion after the operation (1000 cc. was lost by clotting).

ABDOMINAL INJURIES

Case 5 (Fig. 6).—*Diagnosis:* Gunshot wound of abdomen (liver, stomach and spleen); severe secondary shock. *Operation:* Exploratory celiotomy, splenectomy, and closure of stomach wounds; gelatin infusion for shock.

R. T., a 21-year-old male, sustained a self-inflicted gunshot wound of the abdomen (38-caliber revolver). On admission there was a wound of entrance in the left upper quadrant of the abdomen, and a wound of exit in the left loin. Blood pressure initially 120/80, and fell to 80/60; pulse 78, respiration 20, extremities cool and dry. Plasma

GELATIN IN SHOCK

Gunshot Wound of Abdomen

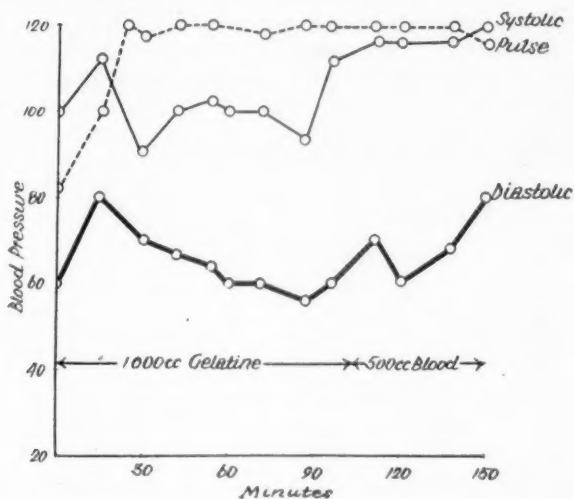


FIG. 6.—Clinical effects of gelatin infusion in a patient with gunshot wound of the abdomen, involving the liver, stomach, and spleen.

Gun Shot Wound of Abdomen

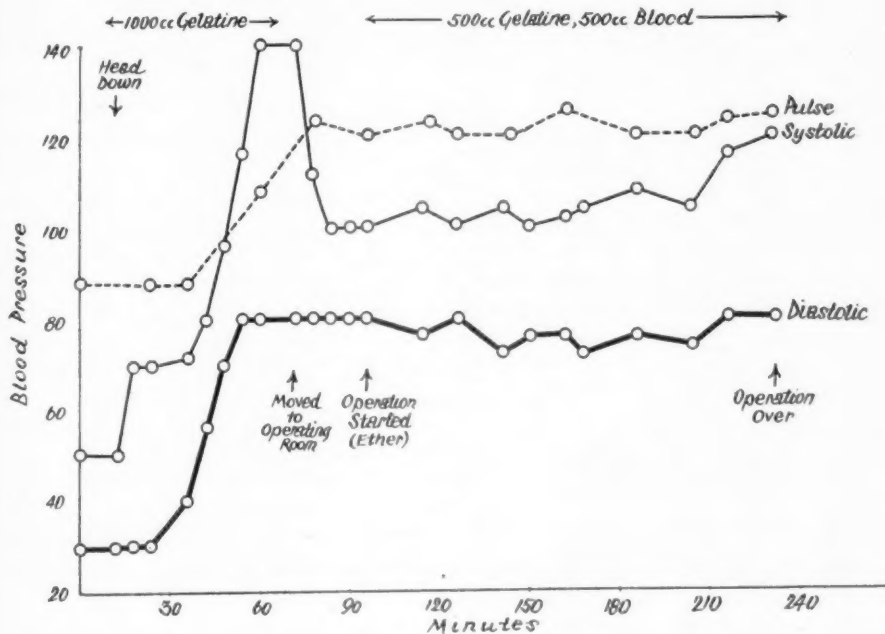


FIG. 7.—Clinical effects of gelatin infusions in a patient with gunshot wound of the abdomen, with severe hemorrhagic shock.

volume 33 cc./Kg., hematocrit 42 per cent, representing a blood loss of approximately 1500 cc. The patient was taken to the operating room and given 1000 cc. gelatin solution, followed by 500 cc. whole blood at the close of operation. At celiotomy, 1800 cc. whole blood was collected. There was a through-and-through wound of the left lobe of liver, a through-and-through wound of the stomach, and a perforation of the upper pole of the spleen, from which blood was issuing. Splenectomy and repair of the stomach wounds were performed. Figure 6 illustrates the operative course of this patient.

Bilateral Traumatic Thigh Amputation

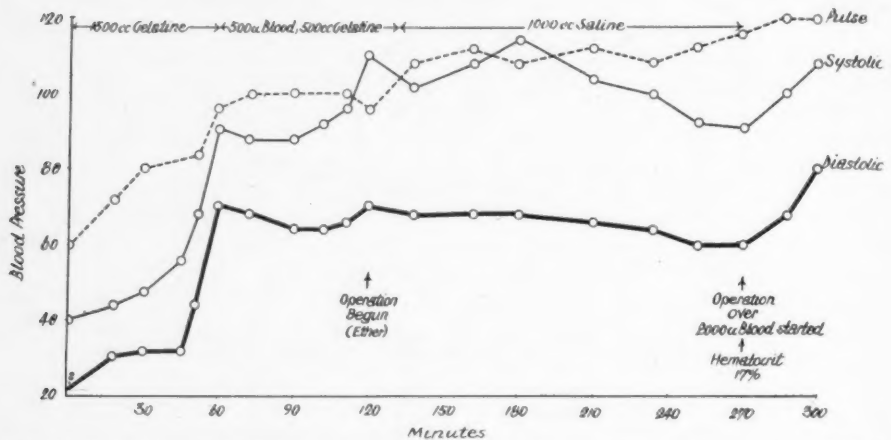


FIG. 8.—Clinical effects of gelatin infusions in a patient with bilateral traumatic amputations of thighs.

Bilateral Fracture of Hip

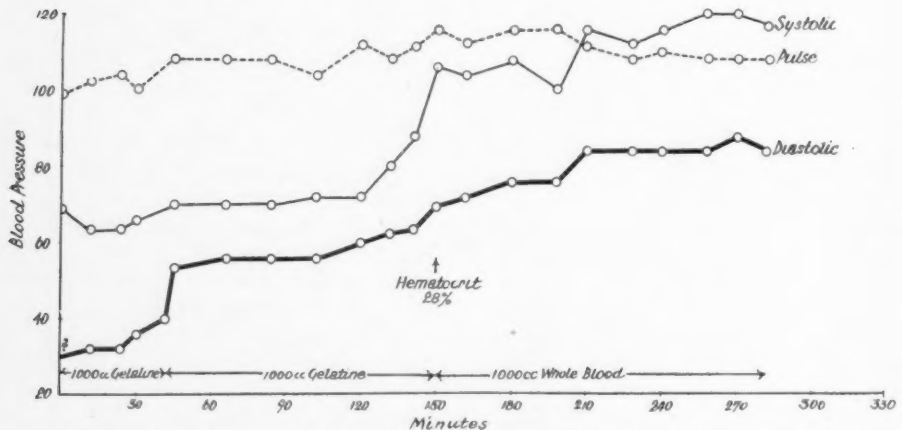


FIG. 9.—Clinical effects of gelatin infusions in a patient with bilateral fractures of hips.

Case 6 (Fig. 7).—*Diagnosis:* Gunshot wound of abdomen; perforation of jejunum; severe hemorrhagic shock. *Operation:* Exploratory celiotomy, closure of jejunum.

G. E. S., a 44-year-old white male, had been shot with a 22-caliber rifle at close range. When seen in the emergency room not long after (30 minutes), he was in a state of profound shock. Blood pressure 50/30, pulse 88, extremities cold and wet with perspiration. Skin bloodless; he was placed in Trendelenburg position, with blood

GELATIN IN SHOCK

pressure rising to 70/30. He was given, by rapid intravenous infusion, 1000 cc. gelatin, and after 40 minutes, when he was taken to the operating room, his extremities had become warm and dry, the blood pressure had risen to 140/80. On opening into the peritoneal cavity, a large amount of free blood was encountered; there were four small openings in the jejunum, which were closed by appropriate measures. There was found an enormous left retroperitoneal hematoma extending from the pelvis to the left renal area. A stab wound was made in the left loin into the hematoma zone.

The patient withstood the operation fairly well, as can be noted from Figure 7. However, about 14 hours after the operation, when he was threshing about the bed, he suddenly collapsed and died before an intravenous infusion could be started. Necropsy showed a severance of the left internal iliac artery in the pelvis, from which the hemorrhage had occurred.

SKELETAL TRAUMA

Case 7 (Fig. 8).—*Diagnosis:* Bilateral traumatic amputation, thighs; severe traumatic shock. *Operation:* Revision of amputation, suprapubic cystotomy; gelatin and blood infusions.

R. C. S., a 34-year-old white male, was run over by a street car. On examination soon after in the emergency room, it was noted that there was a severe crushing injury to both legs from above the knees downward. Tourniquets were applied above the zone of injury. The blood pressure was 40/0, pulse 60, poor volume. Patient was covered with profuse, cold perspiration. He was given 1500 cc. gelatin solution, and blood pressure rose to 90/70. This was followed by 500 cc. whole blood and 500 cc gelatin; the blood pressure rose to 110/70. He was taken to the operating room where, under ether anesthesia, a bilateral thigh amputation and suprapubic cystotomy was carried out. At the close of the operation, 2000 cc. whole blood was given because after the patient had received 2000 cc. gelatin, it was found that the hematocrit had fallen to 17 per cent. (This large whole blood infusion brought the hemoglobin from 35 per cent to 72 per cent). The patient recovered.

Case 8 (Fig. 9).—*Diagnosis:* Intracapsular fracture right hip; fracture dislocation, left hip; severe shock. *Operation:* Deferred.

V. W. W., a 53-year-old, white female, had been in an automobile accident close to Richmond. She was seen by us about 35 minutes after the accident. On admission, the extremities were cold and dry. The skin was very pale; blood pressure was 68/?; pulse 98, poor volume. Raising or lowering the head did not alter the pressure readings. One thousand cubic centimeters gelatin was given rapidly, but pressure rose only to 70/54. A second 1000 cc. gelatin was then given, and gradually the blood pressure rose to 106/78. The hematocrit had by this time fallen from 40 per cent to 28 per cent, so the patient was given, by slow infusion, 1000 cc. whole blood. In four hours, the blood pressure stabilized at 140/90. The plasma volume on admission was 32 cc./Kg., hematocrit 40 per cent.

SEVERE BURNS

To illustrate the effectiveness of gelatin solutions in the treatment of burn shock, we have chosen to present data on two severely burned children. It has been our experience that burn shock is apt to be very severe and difficult to treat in the child, even more so than in the adult. Our experience with the use of gelatin in burns includes now 28 severely burned patients. To show that we have been justified in calling these "severe burns," photographs of four of these patients are shown in Figures 10, 11, 12 and 13.

There has been no death from *burn shock* in this group of 28 patients, although two of this group died on the 12th and 16th day, respectively. One,

a child (Fig. 10), died as a result of injudicious attempts at early removal of slough on the 16th day; the second, a 78-year-old man with a complete third-degree burn of one leg, died on the 12th day, presumably of congestive heart failure.

All things considered, our experience with gelatin in the management of burn shock has been very satisfactory. Our present plan of management



FIG. 10.—Photograph of posterior view of 11-year-old severely burned child. The anterior portion of body was equally as badly burned. Burn shock was well controlled by gelatin infusions given every fourth to sixth hour during the first 48 hours.

is to reserve its use to the first 28-48-hour period when burn shock is most to be feared, and then give whole blood subsequently. From our experience with severely burned children, we now prefer to give fairly large infusions of gelatin at four- to six-hour intervals for the first 24-36 hours; if this is done, burn shock is usually avoided. These infusions are given even though the patient's appearance is good, and without regard for the hematocrit figures. If the burn is largely superficial (second-degree) and is widespread, it is our practice to give somewhat larger gelatin infusions during the "shock" period. Also, we almost routinely give quite large gelatin infusions (250-400 cc.) to small children (3-4 years). In children, the infusions are given by

GELATIN IN SHOCK



FIG. 11.—Photograph (posterolateral view) of severely burned six-year-old child at time of first dressing, on the 14th day. Burn shock was treated by gelatin infusions given every sixth hour during the first 36 hours.



FIG. 12.—Photograph of severely burned child (E. H. Case 2, see text) at time of first grafting. Burn shock was severe in this child, but was successfully managed by gelatin infusions.



FIG. 13.—Photograph of severely burned child (C. J. Case 1, see text) at time of first redressing, on the 14th day. Burn shock was successfully managed by gelatin infusions.

the "rapid syringe" technic, and we have yet to note any evidence that would suggest overloading of the vascular system.

Case 1 (Fig. 14).—*Diagnosis:* Severe burns of entire back, buttocks, upper thighs, face, and arms (second-degree).

C. J., a five-year-old colored boy, was burned when a pail of boiling water fell on him from a stove. He was first seen about 1.5 hours after the accident. On admission,

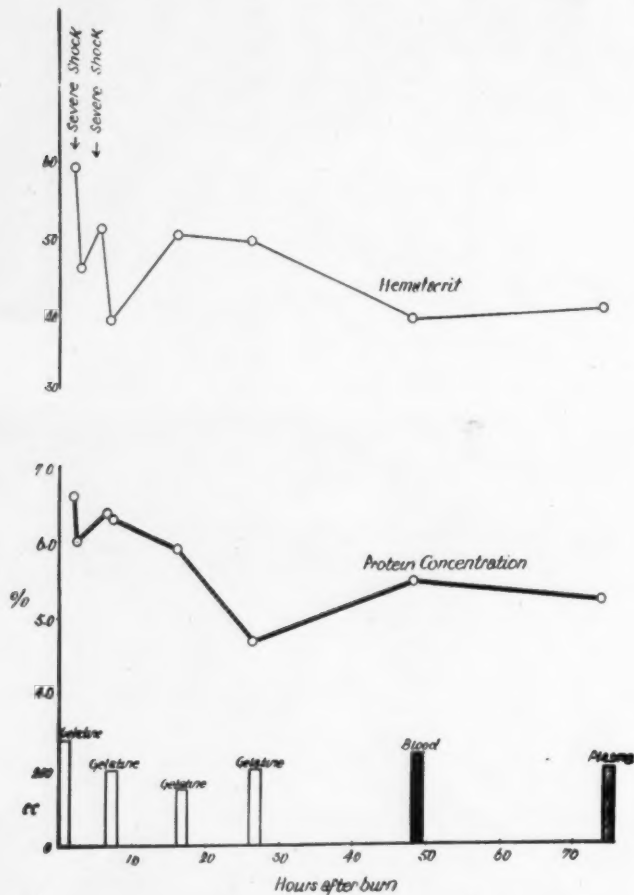


FIG. 14.—Chart illustrating the effects of gelatin infusions in a severe burn (Case 1, C. J.) in controlling hemoconcentration.

the child appeared almost moribund; no pulse could be felt even at the femoral artery in the groin. Extremities were cold and dry. Initial hematocrit 59 per cent, total plasma protein 6.6 per cent. Child was given, by rapid infusion, 350 cc. gelatin into femoral vein. In about ten minutes, child was alert, asking for his mother. Three hours later, although the hematocrit was only 51 per cent, the child was again in shock (cold extremities, very poor pulse volume) so he was given another 250 cc. infusion of gelatin. (Blood analysis showed that no gelatin remained in blood stream of that given earlier). Subsequently, he was given additional gelatin infusions at the 16th and 26th hours. The child began to show clinical evidence of burn toxemia at about the 48th hour, but this had disappeared by the 6th day. The plasma protein

GELATIN IN SHOCK

dropped to 4.7 per cent on the 6th day, despite two blood transfusions and 250 cc. plasma. Figure 14 illustrates the course of treatment and response in this child.

Case 2 (Fig. 15).—*Diagnosis:* Severe burns of entire right leg, right abdomen, and chest (third-degree).

E. H., a small six-year-old white boy had his clothes catch on fire. On admission, he did not appear to be in shock. The burns were obviously third-degree in nature. The

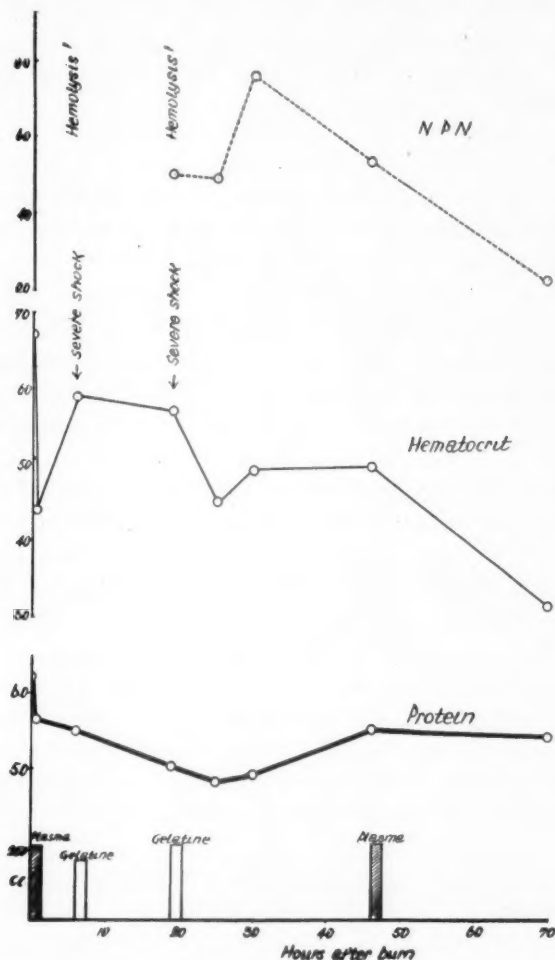


FIG. 15.—Chart illustrating the effects of gelatin infusions in a severe third-degree burn (Case 2, E. H.)

ordinary sulfanilamide gauze pressure dressings were used, 250 cc. plasma being given prophylactically. About five hours later the child was in profound shock, the blood pressure 60/40, pulse 160, poor volume. (Hematocrit on admission was 67 per cent, but had been brought to 44 per cent by the plasma infusion). Hematocrit at the fifth hour was 59 per cent, and the plasma showed definite signs of free hemoglobin. Two hundred cubic centimeters gelatin was given by rapid infusion, the blood pressure immediately rising to 110/70, and the pulse fell to 120. Orders were left for the patient to receive 250 cc. gelatin in six hours (during the night) but these were disregarded by the intern "because he looked so well." Early in the morning, the burn team was called because the patient

was again in shock (blood pressure 60/30, pulse 160), so he was given 250 cc. gelatin by rapid infusion, to which he responded as before. No more gelatin infusions were given. After the third day, regularly, whole blood transfusions were given. Recovery was complete after five skin-grafting operations.

DISCUSSION

THE CLINICAL EVALUATION OF GELATIN FOR SHOCK THERAPY

It is our impression that our experience has now been sufficiently extensive and varied for us to evaluate the clinical value of gelatin solutions in the management of traumatic and burn shock.

ADVANTAGES

(A) One of the chief advantages in gelatin for the management of shock will be its ready availability when it can be supplied in large amounts. The plasma and whole blood program of the American Red Cross has been so eminently successful during the present war that there possibly has been no acute need for substitute. Should large and small hospitals alike experience difficulty in maintaining a steady supply of plasma after hostilities cease, we believe properly selected gelatin solutions will prove helpful in shock management, especially in those smaller centers where it is so difficult to secure plasma.

(B) When large scale production of gelatin solutions can be attained these solutions should be much less expensive than plasma, either desiccated or frozen.

(C) Intelligent use of gelatin infusions in centers where plasma banks can be operated, improves greatly the available supply of plasma. In our own blood bank, where an attempt is made to keep 600 bottles of frozen plasma on hand for emergency use, in the one month, when we were without gelatin this year, our frozen plasma stocks dropped to less than 400 bottles.

(D) From our experience, it is apparent that gelatin is especially indicated during the first 48 hours, since most infused fluid (plasma or gelatin) is lost into the burned area during this period. This results in a large saving of plasma.

(E) *Foreign Protein Reaction.*—With our first supply of gelatin from Doctor Tourtelotte, we saw two moderately severe reactions, one patient showing severe cyanosis and dyspnea, the other moderate urticaria and itching. Since we have been supplied with gelatin solutions free of the preservative phenyl mercuric borate, there has been no instance of foreign protein reaction. Thus, the reactions with gelatin seem to be less frequent than one ordinarily experiences with carefully prepared pooled plasma. Also, we now see practically no venous thrombosis at the site of injection.

(F) Apparently, gelatin infusions can be given in the shock state when renal blood flow has practically ceased without deposition in the kidney. Doctors Phillips and Van Slyke³ have studied this problem extensively in a shock preparation consisting of an isolated single kidney, with the renal vessels clamped-off for four hours, and could find no evidence of renal damage

GELATIN IN SHOCK

from gelatin. The studies of Koop, *et al.*,² demonstrate that gelatin has none of the serious hepatic effects seen when acacia solutions are used.

(G) Although earlier we had feared the possible deleterious effects of large gelatin infusions on the clotting mechanism, prothrombin values seem to remain at normal levels even when as much as 2000 cc. of gelatin solution has been given to patients in shock because of greatly reduced blood volume.

DISADVANTAGES

(A) *Pseudo-agglutination*.—It was earlier noted by Ivy, and his co-workers,⁴ that a serious pseudo-agglutination of erythrocytes occurred when gelatin solutions were given to dogs. This has greatly disturbed some observers, but it seems to have no serious consequences in our clinical experience. In a practical sense, the most serious effect of this reaction is to cause marked *rouleaux* formation during cross-matching after a patient has received an infusion of gelatin. Fortunately, this difficulty has now been obviated by Doctors Koop and Bullitt,⁵ who have demonstrated that if a drop or two of a 1.0 per cent glycine in physiologic saline is added to the erythrocyte-serum suspension (in the cross-matching procedure), this pseudo-agglutination of erythrocytes is abolished.

(B) *Viscosity*.—It must be stated that the gelatin solutions available to us for this investigation were quite viscid, especially if they were cool. For this reason, it is unlikely that 6 per cent gelatin solutions of the molecular size used by us could be used in cold climates, especially during military operations. However, to circumvent this difficulty, on a cold day, we have often diluted the gelatin solutions with equal parts of physiologic saline solutions. If such a mixture is kept at or about 35° C., no difficulty ensues in keeping the infusion running into the vein smoothly and readily.

(C) It can no longer be doubted that one of the greatest needs of a shocked patient is for a greater volume of circulating red blood cells. Therefore, gelatin solutions (as well as plasma) are at a disadvantage when compared to whole blood. For this reason alone, we would emphasize that in the rational management of patients in shock from trauma or burns, gelatin and plasma solutions should be reserved for purely *emergency* use. They can never be considered as true substitutes for whole blood.

SUMMARY

"Lightly and heavily" degraded gelatin solutions have been employed as a substitute for plasma in the treatment of shock caused by trauma or severe burns (Trauma—67 patients; burns—28 patients). Lightly degraded gelatin solutions seem to be retained longer in the blood stream, and appear to be as effective and safe as plasma in the management of these types of clinical shock.

We are indebted to our chief, Dr. I. A. Bigger, who arranged the facilities that made possible these clinical shock studies.

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DISCUSSION.—DR. ALFRED BLALOCK, Baltimore, Md.: There is little I can add to what Doctor Evans has said, and I arise merely to express my thanks for what he has done in connection with the work of the Subcommittee on Shock. He has been working closely with this committee during the past four years, and he has had, with Doctor Bigger's aid, one of the two best clinical programs on shock in this country. The other has been that of Doctor Dickinson Richards and his group, in New York. I have never known a young surgeon who was a more careful clinical observer than is Doctor Evans. So many of us are prone to take to the laboratory problems which could better be studied on man, and Doctor Evans has shown an unusual ability to solve such problems.

DR. HUGH H. TROUT, Roanoke, Va.: I hesitate to discuss Doctor Evans' paper, because I know nothing about the present use of gelatin. As many of you recall, in World War I Hogan's gelatin solution was advocated. In one of the hospitals with which I was connected, we had four deaths following the intravenous use of this solution.

The autopsies in all these cases were done by the late Dr. Hans Zinsser. Doctor Zinsser was interested in these deaths because the solution came from his laboratory at Dijon. In all four cases, the solution had been warmed preparatory to giving it intravenously to the patients. Then something had happened to the patient for whom it was intended, Hogan's solution was then allowed to cool, and it was rewarmed and injected into the four patients that died.

All four of these autopsies showed multiple pulmonary emboli of glycerin. As a result of this experience, there was no further use made of Hogan's solution during the last war. Doubtless Doctor Evans knows about this experience with Hogan's solution, and I would like to hear from him as to what became of this work.

DR. EVERETT I. EVANS, Richmond, Va. (closing): First, as to the problem of using a proper gelatin and getting it now, that cannot be answered. The solutions that Dickinson Richards and I have been working with have been prepared under the personal supervision of an extremely competent chemist, who works 36 hours constantly while runs are being made, to assure us that the material is stable. At present, enough is not being made for widespread use. However, it is likely that in the next few months, after the Food and Drug Committee has gone over this material, we will be able to procure more. The cost of plasma is running high; somebody has to pay for it. The ward patient is charged nothing for it, but it costs somebody about \$20. I am sure gelatin will be sold for about \$1.50 to \$3.00 for 500 cc. The Knox people will not put it out until we can be sure it is safe.

About the matter of Hogan's solution. We are not sure always from which gelatin source it was derived. It can be made from animal skin or bone, or many types of animal tissue. That made in 1918 was not a good solution for intravenous use, and it is likely that Doctor Hogan's solution was gelatin we would be afraid now to use. You must never forget that gelatin, plasma and other materials are not true substitutes for whole blood, and the Sub-Committee on Shock should not be pointed out as remiss for not knowing this; it has been known for at least two years. We must think of these as useful for emergency use, to be followed by whole blood, often in very large amounts.

I am grateful for the remarks of Doctor Blalock, and I can say that it has been tremendously interesting to carry on in a clinical manner what Doctor Blalock has kept going from the last war to this. Without his work I am sure we would have started at a place far behind what he has given to us by his beautifully conducted animal experiments.

PENTOTHAL — METRAZOL ANTAGONISM*

A METHOD OF SHORTENING THE RECOVERY PERIOD FOLLOWING
PENTOTHAL ANESTHESIA
A CLINICAL AND EXPERIMENTAL STUDY

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ALTHOUGH the ideal anesthetic agent for all major surgery has not yet been found, much progress has been made in anesthesia and the development of anesthetic drugs during the past decade. Among these advances are those associated with intravenous anesthesia, which has appealed not only to the experienced anesthetist, but to the surgeon and to the laity as well. When skillfully used, intravenous anesthesia displays advantages which make it the method of choice in many instances.

The first record of general anesthesia produced by the intravenous administration of a drug was reported in 1872 by Oré,¹ who used chloral hydrate. In subsequent years hedonal-chloroform, chloroform, ether, paraldehyde and alcohol were, likewise, employed in this way. More recently the newer drugs, sodium amytal, nembutal (pentobarbital sodium) and evipal, have found favor. To Lundy goes the credit for first using sodium pentothal (thionembutal). Since his first reports^{2, 3, 4, 5} on the use of sodium pentothal for intravenous anesthesia, more than 600 related articles have appeared in the literature.

Initially, the short-acting barbiturates or the intravenous anesthetic agents having a transient effect were advocated only for short operations. However, the "technic of intermittent administration" introduced by Lundy⁶ has permitted their application to longer operations. Sodium pentothal possesses many advantages recommending its use for prolonged surgical anesthesia. To the patient it is a nonirritating, odorless material inducing sleep rapidly and pleasantly and permitting comfortable recovery. For the surgeon it provides effective muscular relaxation without excessive capillary bleeding and, destroyed rapidly, it causes a minimum of functional and no organic injury during or after administration. In addition, it is inexpensive and can be stored without risk of chemical change.

While the advantages of intravenous pentothal anesthesia are many and varied, and certainly far outweigh the disadvantages, nevertheless, two faults

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are recognized. The first is the apparent increase in the depth of anesthesia or narcosis which occurs at the termination of the operation when stimulation is no longer present and which is followed by a *prolonged period of sleep*. This postoperative period of sleep in some instances may last as long as eight or twelve hours, being, in general, proportional to the amount of sodium pentothal administered. While in some patients the prolonged period of postoperative unconsciousness is beneficial, in others it may be harmful. Pickrell has demonstrated that in experimental animals anesthetized with ether, avertin,⁷ or pentothal⁸ or in profound narcosis produced by the ingestion of ethyl alcohol,⁹ resistance to bacteria is lowered. Bacteria aspirated into the respiratory tract under these conditions grow uninhibited during the period of unconsciousness. The lessened resistance appears to be related to profound inhibition of the vascular inflammatory response, in the absence of which leukocytic emigration does not occur. Bacteria growing unrestrictedly under these conditions for several hours may become overwhelmingly numerous. If bacterial growth is unchecked, septicemia may ensue and death occur.

The second disadvantage in the use of sodium pentothal given intravenously is the possible occurrence of a state of *profound respiratory depression* which may be seen during any stage of the anesthesia. For the most part, the larger the amount of pentothal given, the greater is the tendency toward development of this condition. In some instances the state of depression may terminate in complete respiratory failure and death.

While untoward effects of pentothal are seen relatively infrequently, it is imperative to seek a means for averting the difficulties associated with respiratory failure and for alleviating the probably harmful condition consequent to prolonged narcosis. The latter is of especial importance in the instance of aged patients. Pentothal, in common with the other barbiturates, exerts a depressant action on the cerebrospinal axis and produces an effect varying from slight sedation to deep coma. In large doses the barbiturates depress directly the medullary respiratory center and both the depth and rate of breathing are decreased and irregular. To counteract these effects, several drugs have been employed. Those in common use are the respiratory stimulants coramine, caffeine, and picrotoxin. Another potent stimulant of this class, known for the past two decades, is metrazol. Synthesized in 1923,¹⁰ metrazol is classified pharmacologically as a central convulsant drug, similar in this respect to picrotoxin.

Metrazol was early found to possess a potent action antagonistic to the effects of various narcotics. Schoen¹¹ studied the arousing influence of the drug in narcosis induced by urethane, alcohol and paraldehyde. Extending the studies, Tartler¹² demonstrated a like effect of metrazol in narcosis caused by sodium barbital, and Barlow¹³ encountered the same finding in his extensive experiments with pentobarbital. In all of these experiments with barbiturate narcosis in animals, the mouse, rat, rabbit and dog, it was regularly found that, while its effects varied somewhat with the species, metrazol not only exerted a strong action to arouse the organism in narcosis, but, under

proper conditions of dose and time and route of administration, protected completely against lethal doses of barbiturates.

Though these pharmacologic qualities of metrazol have long been established, few reports have been made of its action in pentothal narcosis in either animals or man. Piekenbrock and Olson¹⁴ used three cubic centimeters of metrazol intravenously after pentothal anesthesia and found the drug to be "a most efficient denarcotizing agent, and by its use the anesthetic state will be terminated promptly and any undesirable depression avoided." Reynolds¹⁵ considered metrazol to be a more effective analeptic agent than coramine, alpha-lobelin, or picrotoxin in arousing cats or dogs anesthetized with pentothal.

The possible value of metrazol in the prevention of prolonged pentothal narcosis and for the resuscitation of patients in profound respiratory depression was recently strongly impressed on the authors as the result of its effects in the treatment of a case to be described in a subsequent section. This experience has suggested further investigations of the drug in this respect. Clinical studies have been made of the arousing action of metrazol in patients anesthetized with pentothal and of its restorative action in respiratory and circulatory failure. These studies were supplemented by an examination of the effects of the drug in pentothal narcosis in rabbits and dogs. The results observed are described in the present report.

CLINICAL STUDIES

As noted above, the possible value of metrazol in counteracting the undesirable actions of pentothal was brought to the attention of the authors by difficulties experienced with a patient anesthetized with the drug.

The patient was a woman, age 24, who, several years before, had received extensive burns about the axilla. Subsequently, contractures developed between the trunk and the upper arm. Approximately 30 minutes after the beginning of an operation for the repair of the deformity, the patient's respirations suddenly ceased. There was no obstruction of the air passages, and the pulse rate and blood pressure had been normal. A total of 0.6 Gm. of sodium pentothal in 2.5 per cent solution had been given. Artificial respiration was started immediately. Coramine, picrotoxin and caffeine in appropriate amounts were administered in rapid succession, but without evident effect. Death seemed imminent. The patient was cyanotic, and the pulse was barely perceptible. Five cubic centimeters of metrazol* were then administered intravenously, and almost immediately respirations were resumed, the pulse became full and strong, and consciousness was soon regained. Shortly, sodium pentothal was again rather cautiously administered, and the operation was completed within an hour. While the patient was still on the operating table, an additional three cubic centimeters of metrazol

* The metrazol used throughout the present work was the 10 per cent aqueous solution supplied commercially by Bilhuber-Knoll Corp., Orange, New Jersey.

were administered intravenously. The patient quickly recovered consciousness and expressed a desire to learn the results of the operation.

In this case it appeared likely that life was preserved chiefly by the action of metrazol, though the coramine, caffeine and picrotoxin administered may have exerted some influence on the result. The reviving action of metrazol at the depth of respiratory depression and the subsequent arousing effect at the termination of the operation were so striking that further clinical observations were undertaken.

The investigations with patients consisted essentially in the study of the effects of metrazol on the length of the recovery period after pentothal anesthesia. A series of observations was made first on the *average length of the recovery period* of 80 patients anesthetized with pentothal in the usual way, without subsequent administration of stimulants. In a second series of patients, more than 300, studies were made of the arousing effect of metrazol given intravenously at or near the close of the operative procedure. Pre-operatively, each patient received an hypodermic injection of 0.6 mg. atropin and 10 to 12 mg. morphine.

The procedure of anesthetization with pentothal was carried out in accordance with the "technic of intermittent administration" (Lundy,⁶ Cameron¹⁶ and Davison and Rudder¹⁷). Pentothal in a 2.5 per cent solution was slowly administered intravenously, in combination with a mixture of 5 per cent glucose in 0.85 per cent saline. The dextrose was included, since Sise¹⁸ has shown that when the liver is well supplied with glycogen and when there is no lack of oxygen, liver damage does not occur. Richards has demonstrated that the use of the intermittent method allows one increment of pentothal to be partly detoxified before the next is administered.¹⁹ Pentothal is given only to adults, and the maximum dose does not exceed 2 Gm. (80 cc. of a 2.5 per cent solution). Lundy²⁰ has demonstrated that the incidence of phlebitis in the vein receiving the solution is directly proportional to the concentration of the drug. The importance of a continuous supply of oxygen as a supplement has been stressed by many writers, notably Lundy and Adams,²¹ Lahey,²² and Ravdin.²³ Most investigators believe that anoxemia is the basis of many anesthetic difficulties, for it has been demonstrated that the barbiturates as a class affect the respiration by decreasing its depth. For this reason, the continuous administration of oxygen in high concentration is maintained during the entire anesthetic period.

The patients studied for the determination of the length of recovery period when no metrazol was given were carefully observed from the beginning of the anesthesia through the operation, and postoperatively until the patient could be readily aroused. As was to be expected, so many variables were found that it was difficult to determine an average recovery time. The amount of pentothal given, the weight and stature of the individual, the site and the extent or magnitude of the operation all affected the time of recovery. With the continuous stimulation and pain from the incision following operations upon the chest or the abdomen where the part could not be completely

immobilized, the recovery period was relatively short. In such cases in which the patients weighed less than 176 pounds (80 Kg.) and received 1.5 Gm., or less, of sodium pentothal, the average recovery period was 1.5 hours. In instances in which the operative site was the extremities, scalp or face, where immobilization could be effected, the recovery period was definitely longer. The average period for such patients given 1.5 Gm. or less of sodium pentothal was three hours with variations of 30 minutes to six hours.

In the group of 80 patients, there were 30 individuals weighing more than 176 pounds (80 Kg.) but less than 190 pounds (86 Kg.). The amount of pentothal given did not exceed 2 Gm., and in no instance did the operation last for more than two hours. The average recovery period for these patients with well immobilized operative sites was 3.5 hours. In the instances of those with poorly immobilized operative wounds, the period was two hours. While these values represent the average, in four patients the period exceeded six hours, in three patients, eight hours, and in two patients, 12 hours.

The Influence of Metrazol on the Length of the Recovery Period.—The patients arranged in this category of the studies were given pentothal in the same way and in the same amounts as those not treated with metrazol. At the conclusion of the operation and the application of dressings, five cubic centimeters of metrazol were administered very slowly through the needle used for the introduction of the pentothal and the glucose-saline solution. In some instances, an additional quantity of three cubic centimeters of metrazol was given. The total dose was never more than eight cubic centimeters.

In all except 16 instances of more than 300, recovery took place either immediately or within 30 to 45 minutes after the patient was returned to the ward. In the 16 cases, in all of which the maximum dose of 2 Gm. of pentothal had been given, recovery took place within 1.5 hours after the intravenous injection of metrazol.

The Restorative Effect of Metrazol in Respiratory Depression.—Profound respiratory depression was seen and treated in six instances in addition to the case cited above.

CASE REPORTS

Case 1.—Male, age 25. In preparation for radical dissection of the neck, intubation was undertaken. The patient's pharynx had not been treated with local anesthetic and difficulties were encountered in the intubation process because of lightness of anesthesia. In order to attain the desired depth of anesthesia, the dose of pentothal was increased. When 0.8 Gm. had been given, the respiratory movements ceased. There was no visible obstruction of the air passages. The patient was given immediately 5 cc. of metrazol intravenously. Without the aid of artificial respiration, active respiratory movements were established within 30 to 45 seconds and consciousness was restored within two minutes.

Case 2.—Male, age 48. The conditions leading to respiratory failure in this patient were essentially identical with those of Case 1. Respirations ceased when the amount of pentothal administered was 1 Gm. Metrazol was given in 5 cc. volume and recovery occurred as in Case 1.

Case 3.—Male, age 45. This patient had been given 100 mg. of novocaine intraspinally as the primary anesthetic agent for lumbar sympathectomy. About 15 minutes

later, during the course of the operation, the patient experienced severe pain in the operative wound. He was then given 0.8 Gm. of sodium pentothal rather rapidly. Several minutes later, respiratory movements ceased, the blood pressure fell, and the pulse became imperceptible. He was given 5 cc. metrazol intravenously. Irregular respiratory movements began almost immediately and the pulse could be felt. After three or four minutes, an additional 3 cc. of metrazol were given intravenously. The respiratory movements resumed a regular rate, rhythm and depth, and, in addition, consciousness was almost fully restored.

Case 4.—Female, age 38. When this patient had received a total of 1.6 Gm. of pentothal, within 1.5 hours after the start of a radical mastectomy, her respirations ceased. Five cubic centimeters of metrazol were given and normal respiratory movements had begun at the termination of the injection. This dose of metrazol did not restore consciousness. No additional pentothal was necessary for completion of the operation, which was finished 30 minutes later. Three cubic centimeters of metrazol were then administered, and consciousness returned before the patient was removed from the operating room.

Case 5.—Female, age 19. During the preparation of an abdominal tube-flap, 45 minutes after the onset of complete anesthesia, the patient had received 1.2 Gm. of sodium pentothal. At this time the respirations became irregular and weak, although they did not cease. After the administration of 3 cc. of metrazol, normal respiratory movements were resumed. The patient remained asleep and operation was continued.

Case 6.—Male, age 56. This patient showed the presence of extensive granulating surfaces of the legs resulting from burns. After the operation for skin grafting had been in progress 80 minutes, at which time the grafts were being sutured to the granulating surface, the patient's respirations became irregular, shallow and then stopped. He had received 1.8 Gm. of pentothal. The blood pressure and the pulse volume and rate were essentially normal. Artificial respiration was tried for at least three minutes, but was ineffective in stimulating voluntary breathing. Metrazol, 5 cc., was then administered intravenously, and within less than 30 seconds, irregular respirations began. Within three to four minutes the respiratory movements were full and normal. There was some movement of the lower extremities. Consciousness was not regained at this time. The operation was completed within 30 minutes, during which the patient received 0.2 Gm. more of pentothal. At the termination of the operation and after application of the dressings, an additional 3 cc. of metrazol were administered. The patient rapidly regained consciousness.

In these patients, no untoward reactions or ill effects have been noted, nor have convulsions occurred. There have been no instances in which postoperative fever or tachycardia could be attributed to the metrazol. No evidence has been seen of sensitivity or of localized reactions at the site of the intravenous injection. There have been no generalized phenomena, except the recovery of consciousness.

EXPERIMENTS WITH ANIMALS

Experiments were made in order to study the analeptic or restorative effect of metrazol in intravenous pentothal anesthesia in rabbits and dogs. For this 64 rabbits and 20 dogs were used.

EXPERIMENT I.—The first study was concerned with the determination of the average recovery time following pentothal anesthesia in rabbits. For this, 16 rabbits were injected intravenously with 25 mg. per Kg. of pentothal in a 2.5 per cent solution. Measurements of time were made from the onset of unconsciousness until (a) the animal started to right itself with its head and front legs—the *righting period*; and (b) the animal could resume its normal position—the *recovery period*.

PENTOTHAL—METRAZOL ANTAGONISM

These periods, measured from the beginning of the anesthesia were: (a) 27 minutes, with a variation of 15 to 43 minutes; and (b) 40 minutes, with a range of variation of 19 to 53 minutes.

EXPERIMENT II.—An attempt was made to interrupt completely and permanently the deep pentothal anesthesia in rabbits by the administration of metrazol. The same group of rabbits that had been used in the previous experiment, plus 16 additional rabbits, was employed. All were given 25 mg. of pentothal per Kg. in a 2.5 per cent solution into the ear vein. After 12 minutes, when the rabbits were deeply anesthetized, 100 mg. per Kg. of metrazol were administered intravenously. This resulted in an almost immediate "righting" of 30 of the 32 rabbits. Within two minutes after the metrazol injection, all animals had raised their heads and front legs, and the "recovery" of every individual was complete within ten minutes after injection of the metrazol.

EXPERIMENT III.—For this experiment a more prolonged pentothal anesthesia was produced in 12 rabbits by the simultaneous injection of 20 mg. of pentothal per Kg. intravenously, and 35 mg. per Kg. of pentothal intraperitoneally. The average "recovery period" of the 12 animals was 48 minutes. The longest period of anesthesia was 70 minutes.

EXPERIMENT IV.—The same group of animals employed in Experiment III and, in addition, 12 other rabbits were given 20 mg. of pentothal per Kg. intravenously, plus 35 mg. of pentothal per Kg. intraperitoneally. After 30 minutes, when each animal was deeply anesthetized, 50 mg. of metrazol per Kg. were given intravenously. In each instance, complete recovery had occurred within five minutes after injection of the metrazol. No convulsions were seen in any of the animals, although slight transitory twitchings were occasionally observed.

These experiments clearly demonstrate that it is possible to interrupt completely and permanently a profound pentothal anesthesia in rabbits by the intravenous administration of metrazol.

EXPERIMENT V.—In this experiment studies were made on 12 dogs. Each animal was given 20 mg. of sodium pentothal per Kg. intravenously, and 20 mg. per Kg. intraperitoneally. The sleeping phase and the time for complete recovery, i.e., when the dog could stand or walk, were noted. The average period for the group was three hours and 40 minutes. Several days later the same dogs were anesthetized in a like manner. After profound anesthesia had been continued for two hours, four dogs were given 35 mg. per Kg. of metrazol intravenously, four were given 30 mg. per Kg., and four were given 25 mg. per Kg. The dogs receiving the 35-mg.-dose developed convulsions without shortening of the period of unconsciousness, and those receiving the 30-mg.-dose developed subconvulsive twitchings without regaining consciousness immediately. The dogs that received the 25-mg.-dose of metrazol developed transitory twitchings and were quite ataxic during the recovery phase.

EXPERIMENT VI.—It was apparent from the results of Experiment V that immediate interruption of profound sleep in dogs due to pentothal was not possible through the administration of metrazol. It is well known that a considerable period of ataxia follows prolonged pentothal anesthesia in this species.

Therefore, in connection with the clinical purpose of the investigation, a further study was made of the possibility of shortening the *recovery time* after pentothal anesthesia in dogs, that is, the time for complete recovery after the first evidence of awakening.

For this purpose, eight dogs were given 20 mg. of pentothal per Kg. intravenously, and an equal amount at the same time intraperitoneally. Sleeping and recovery times as defined above were observed. Several days

later, the experiment was repeated and metrazol in doses of 20 to 37 mg. per Kg. were injected intravenously at the moment when the dogs began to awaken. As shown in Table I, there was a marked and constant reduction of the recovery time in every instance.

TABLE I

EFFECT OF METRAZOL GIVEN INTRAVENOUSLY UPON THE RECOVERY TIME OF DOGS ANESTHETIZED WITH SODIUM PENTOTHAL (20 mg./Kg. Intravenously + 20 mg./Kg. Intraperitoneally)

Dog. No.	Sleeping Time		Metrazol I. V. at End of Sleep*	Recovery Time		Remarks
	Hrs.	Mins.		Hrs.	Mins.	
69	1	45	None		30	Transitory twitching, slight ataxia, walks
	1	36	35 mg./Kg.		12	
73	4	14	None	1	23	Walks immediately, slight ataxia
	3	15	35 mg./Kg.	1	1	
74	5	47	None	1	30	Short attack of mild convulsions (fast injection), walks with some ataxia
	4	15	35 mg./Kg.		3	
75	5	00	None	1	50	Walks, slight ataxia
	5	25	20 mg./Kg.		4	
77	7	14	None		37	Partly paravenous injection, walks after 15 min.
	4	05	35 mg./Kg.		15	
I	3	12	None	1	58	Sits up after first dose, walks after second
	2	57	35 mg./Kg. + 12 mg./Kg.		9	
V	2	10	None	1	05	Slight transitory trembling, walks
	1	05	35 mg./Kg.		2	
Chow	4	27	26 mg./Kg.		1	Walks immediately, no ataxia

*The time at which the dogs started to raise their heads and made attempts to right themselves was taken as the end of the sleep.

DISCUSSION.—Metrazol is a synthetic tetrazol compound, which is extremely stable and cannot be broken down or changed except by vigorous chemical procedures. It exerts a prompt and intense stimulating action on the vasomotor and respiratory centers in the medulla and on the cerebral cortex. This effect on the medullary centers is much more prominent when their functions are in a state of depression. When the circulation has been depressed by an hypnotic agent, metrazol causes a marked rise in blood pressure. It is relatively nontoxic insofar as the amount necessary to produce serious poisoning is concerned.²⁴ Its action is practically instantaneous when the drug is administered intravenously. It is absorbed very rapidly also when given by subcutaneous injection or by mouth. This is partly due to its extreme solubility in water. Its effects usually last 0.5 to 1.5 hours. It is rapidly detoxified, and its effects are not cumulative.

Pentothal, in common with all of the barbiturates, exerts a depressant action on the cerebrospinal axis. The depressant action may be employed in varying degree to induce calmness or sleep; to depress the motor cortex for the prevention of convulsions; and to produce partial or complete surgical anesthesia. In large doses the barbiturates act directly to depress the circulatory or respiratory center, especially the latter. In respiratory depression both the rate and depth of breathing are decreased, and the rhythm may be irregular. The barbiturates, even when used intravenously for

anesthesia, are not directly toxic to the myocardium, nor do they seriously alter the cardiac rhythm or conduction. A fall in blood pressure may result from the rapid intravenous injection of a relatively safe dose of a barbiturate, but the hypotension is transitory if the dose is not too large. Ectopic beats have been explained as the effect of transitory anoxemia and vanish when oxygen is given.

Consideration of the properties of metrazol and of the barbiturates in general reveals at once their essentially opposite pharmacologic effects. The expectation of possible antagonistic behavior when metrazol and the barbiturates are introduced into the same organism has been borne out in numerous investigations with animals. Tartler,¹² in 1929, showed that narcosis produced in the rat by sodium barbital in doses of 20 mg. per 100 Gm. of body weight was completely overcome by half the normal convulsant dose of metrazol, 2 mg. per 100 Gm. of body weight. Doses of 3 mg. of metrazol, or more, resulted in permanent awakening. Conversely, Mehl²⁵ found that sodium barbital in quantities of 20 mg. per 100 Gm. of body weight protected rats against lethal doses of metrazol. These findings have been corroborated by many authors. As might be expected, the ultimate effect of metrazol is greatly dependent on the time of administration with respect to the introduction of barbiturates. The antagonism of the action of metrazol to that of sodium barbital in mice was established by Zipf, and his coworkers.²⁶

Somewhat similar antagonisms between barbital and metrazol have been observed in rabbits and dogs. Barlow¹³ found that narcosis in rabbits caused by 40 mg. per Kg. of pentobarbital was greatly shortened by metrazol and lethal doses were overcome. Rabbits given large doses of sodium barbital, 150 to 200 mg. per Kg., were aroused immediately by intravenous injection of 25 mg. per Kg. of metrazol. The animals soon went back to sleep, however, and the state of consciousness was maintained only by the administration of repeated doses of metrazol. Koppanyi, Linegar and Dille²⁷ showed that metrazol given in divided doses would protect dogs against about three times the lethal dose of sodium barbital. Such animals did not awaken immediately but recovered ultimately.

Reports of studies on the antagonistic effect of metrazol in pentothal anesthesia have been limited. Reynolds¹⁵ injected dogs and cats with an amount of pentothal just sufficient to stop respiration. When artificial respiration did not initiate active respiratory movements, picrotoxin, coramine, alpha-lobelin, and metrazol were administered. Metrazol was found to be the most effective analeptic agent. Piekenbrock and Olson¹⁴ inject three cubic centimeters of metrazol intravenously following the termination of each pentothal anesthesia. These authors found it to be "a most efficient denarcotizing agent, and by its use the anesthetic state will be terminated promptly and any undesirable depression avoided."

The results obtained in the present work have shown that metrazol is an effective arousing agent in pentothal anesthesia in rabbits, a finding which parallels that of the previous investigations with sodium barbital and

pentobarbital in this animal. Under the conditions of the experiments, metrazol did not arouse dogs immediately from deep surgical anesthesia. In this respect, a species difference between rabbits and dogs is evident. However, it was clearly shown that the period of recovery of dogs, that is, the period from the beginning of awakening to complete recovery, could be markedly shortened by the action of metrazol. This result is in partial disagreement with that of Mousel and Essex,²⁸ who found metrazol and other analeptics of no value in treating severe depression caused by pentothal in experimental animals. The doses of metrazol used by these investigators were too low to permit final judgment on its usefulness. Furthermore, the present study has chiefly another object, namely, investigation of the possibility of shortening the recovery period after prolonged, but otherwise normal, pentothal anesthesia.

The findings in man, both from the point of view of the arousing effect of metrazol in surgical anesthesia with pentothal and its action to stimulate resumption of respiration in acute depression were most striking and, on occasion, dramatic. In this series of observations, the response of man anesthetized with pentothal appeared both quantitatively and qualitatively similar to that of rats and rabbits under the influence of sodium barbital and pentobarbital. While it was not possible completely to control the clinical studies, it was evident that metrazol was effective in markedly shortening the recovery period after surgical anesthesia and in arousing or protecting patients profoundly depressed by pentothal.

It should be emphasized that the use of metrazol is not recommended as a routine procedure but only in those cases in which indications for it are evident. In instances in which there is evidence of awakening at the termination of the operative procedure, the use of metrazol is not only unnecessary but may be harmful. With the wane of pentothal effect, there is a proportional increase in susceptibility to the convulsive action of metrazol. In the latter stages of pentothal effect, therefore, metrazol may induce convulsions.

It should be noted, further, that the pharyngeal reflex is not greatly diminished by sodium pentothal. For this reason, when intubation, bronchoscopy, or operations upon the throat are to be performed, the throat should be sprayed beforehand with a local anesthetic agent, such as pontocaine or cocaine.

SUMMARY

Studies were made on the antagonistic effect of metrazol in patients under sodium pentothal anesthesia. In control studies in which no metrazol was given the recovery from pentothal anesthesia varied from 1.5 to 12 hours, depending upon the size of individual and the dose given, and upon the magnitude of the operation. Patients weighing less than 176 pounds (80 Kg.) and receiving 1.5 Gm. of sodium pentothal recovered consciousness in an average period of three hours, when immobilization of the operative wound could be effected. In instances in which the operative site could not be immobilized, the average recovery period was 1.5 hours. Larger patients,

those weighing 176 to 190 pounds (80 to 86 Kg.) and who did not receive more than 2 Gm. of pentothal in operations lasting no more than two hours, recovered in an average period of 3.5 hours where the operative site was well immobilized. A shorter recovery period, two hours, was observed in patients in whom the operative site could not be immobilized.

In a series of more than 300 patients given pentothal in the same amounts and manner as for the control group, 5 to 8 cc. of metrazol were administered intravenously. The recovery period, except in 16 instances, was not more than 45 minutes. Frequently, recovery of consciousness occurred almost immediately. In the 16 patients, all of whom received the maximum dose of 2 Gm. of pentothal, recovery was delayed for not more than 1.5 hours.

In seven patients recovery from profound respiratory depression was effected quickly and so completely that operation could be resumed with the administration of additional pentothal.

Studies were made also of the arousing action of metrazol in pentothal anesthesia of rabbits and dogs. Narcosis in rabbits comparable in depth to surgical anesthesia was interrupted within five minutes and recovery was complete in every individual within ten minutes after the injection of metrazol. Dogs given metrazol during the stage of profound anesthesia could not be awakened immediately, but when metrazol was given at the first indication of awakening, the subsequent period of recovery was markedly shortened.

CONCLUSIONS

The administration of metrazol given intravenously markedly shortens the recovery phase following sodium pentothal anesthesia in man. In addition, it has relieved profound respiratory depression which has occurred in seven instances in the present study.

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DISCUSSION.—COL. WALTER DENT WISE, Baltimore, Md.: I think this important paper merits serious consideration and there should be wide dissemination of the information, which might well counteract the bad effects of pentothal. I rise simply to add my word of warning about the danger of this splendid anesthetic which is certainly, as someone has said, heaven-sent for use under present circumstances, particularly in the Navy; and also of great value in the Army. We have not had, I am glad to say, in my Service Command, as much difficulty as I have learned about in civilian hospitals.

It came to my attention two or more years ago that there were quite a number of catastrophes in civilian hospitals, possibly because of the casual manner in which it was administered; it was considered a simple procedure, apparently. The patients were not properly prepared, the choice of case was not well made, and there were some very disastrous results. All one need do is to mention this in a group of surgeons and someone will say: "I know of a catastrophe or near catastrophe"—and relate one or more

instances. As an illustration, I was asked to investigate a situation in one of our schools. I found in one civilian hospital two recent deaths, one a student, one a woman, and from the description of the death of the student I imagine he could have been saved had metrazol been used. I think everything else was used. The chief thing I would emphasize is that it is a dangerous drug to use. It is a wonderful anesthetic, but it cannot be used by people who are not qualified, and it must be stressed that it cannot be used casually and with free-wheeling.

DR. E. I. EVANS, Richmond, Va.: Just a few words about our experiences with pentothal. In shock patients, in trying to shorten the time of anesthetic recovery, we were not very successful with either metrazol or picrotoxin. I think everyone who uses pentothal much should inform himself by reading Dr. Carl Moyer's paper published about a year ago, which contained certain facts not well known. I have seen anesthetists, when they got into trouble, start doing things which his work shows will be of little value. They ask: "Shall I give CO₂?" He points out that this is one of the worst things to do. Even high oxygen concentration seemingly does more harm than good at that time. The chief thing, if you get into trouble and do not have metrazol handy, is to use artificial respiration by pressure on the lower border of the costal cage. (That does not mean you can do the same by intermittent positive pressure). To that can be added painful stimuli, such as slapping the costal cage. His contribution on this is most important.

MAJOR BARNES WOODHALL, Washington, D. C.: About two years ago we reported a series of 378 major neurosurgical procedures carried out under a combination of pentothal and oxygen anesthesia. We were pleased with our results chiefly, it must be added, because this anesthesia lowers intracranial pressure. However, there were three patients in this group who suffered severe respiratory depressions and we were quite worried about these individuals. Those of you who were at Ashford General Hospital on Monday will recall that Captain Galvin reported another group in which this agent had been used also for long operative procedures. On the other hand, the Surgeon-General's office has reported six times as many complications with pentothal anesthesia as with any other anesthetic agent. Doctor Pickrell's contribution, therefore, will be of considerable value to the surgeon using pentothal. The major complication we have encountered, even under what we considered proper conditions, has been laryngeal spasm.

DR. ALTON OCHSNER, New Orleans, La.: It might be well to call attention to the fact that metrazol is also not without danger. Those who have seen it used in shock therapy will appreciate that it is a drug that must be used cautiously.

DR. KENNETH L. PICKRELL, Durham, N. C. (closing): In answer to Major Woodhall's question relative to stridor and laryngospasm, I believe it is safe to say that there is considerable evidence that pentothal does not induce relaxation of the laryngeal constrictors. In the cases studied in the present work, respiratory and circulatory failure were observed in two patients in association with attempts to intubate prior to operation. Though these patients were under deep anesthesia, laryngospasm was evident and intubation was not possible without additional pentothal. It was clear that the amount of pentothal necessary for induction of laryngeal relaxation closely approached the lethal dose. It is to be noted that the danger associated with laryngospasm, especially in cases in which intubation is necessary, can be partially obviated in the beginning by spraying the throat with a local anesthetic such as pontocaine or cocaine.

In the use of metrazol it is hoped that, by shortening the postoperative period of unconsciousness or the prolonged period of sleep following pentothal anesthesia, morbidity and mortality rates will be lowered. This can be accomplished by decreasing the instances of postoperative pneumonia due to aspiration and hypostatic pneumonia, especially in patients of advanced years. Further, through the initiation of early movement, vascular stasis and the formation of thrombi will be prevented. A great advantage of metrazol is that, in addition, its action promptly and effectively relieves the profound respiratory depression which may occur during any stage of pentothal anesthesia.

It is planned to continue these studies with nitrous oxide, ether, avertin and profound alcoholic intoxication. It is possible that metrazol may be of comparable value in decreasing untoward effects of these materials as well.

HEPARIN IN THE ABDOMEN*

A CLINICAL REPORT

FRANCIS M. MASSIE, M.D.

LEXINGTON CLINIC

LEXINGTON, KY.

SINCE THE REPORT of Lehman and Boys¹ on the intra-abdominal use of heparin to prevent peritoneal adhesions there have been no other reports except by the same authors. For this reason it is necessary to present a brief review of their work, clinical applications, and conclusions.

It had been known for many years that fibrin was the corner-stone in the building of adhesions and that the organization of fibrin was the adhesion. Consequently, if the formation of fibrin could be prevented, it might be possible to keep adhesions from forming. As citrate, oxalate, and hirudin had been tried unsuccessfully, heparin seemed to be a logical weapon with which to attack the problem.

Lehman and Boys produced peritoneal adhesions in dogs by infection (opening and leaving open the appendix) and by trauma² (scarification of surfaces and gauze pledgelets sutured between ileum and cecum). The first method was later abandoned because of the mortality (50 per cent) in the animals. The animals were examined after six weeks and all of the intra-abdominal adhesions noted and separated chiefly by sharp dissection. Careful hemostasis was carried out by fine silk ties and electrocoagulation. Some of these animals were used as controls. In others, various substances were placed in the abdomen at the time of the separation of the adhesions and subsequently by paracentesis. All of the animals were again examined after two to six weeks.⁵ In those where no drug had been used in the abdomen the adhesions had reformed about 130 per cent. Where other substances, normal saline, amniotic fluid (amfetin), and papain were used, the reformation occurred greater than 100 per cent. Only when heparin was used was there a reduction in the number and extent of the adhesions. The percentages were estimated roughly by the number of adhesions cut. Later the width of reformed adhesions was found to parallel their number. When heparin was used the reformed adhesions were found to be about 34 per cent.

These investigators found that the best results were obtained by administering the heparin at the close of the operation and by paracentesis every 12 hours for three days. From these studies they worked out the technic detailed below for clinical use.

The following year they³ reported the use of the method on 14 patients, seven from their own, and seven from three other clinics. Their results

*Read before the Fifty-sixth Annual Session, Southern Surgical Association, December 5-7, 1944, Hot Springs, Va.

have encouraged us to try this procedure on a few (seven) of those obstinate people who seem to reform those adhesions which produce intestinal obstruction. Some people seem to have a tendency to produce adhesions in number and density far above the average. Whether this is due to a "fibroplastic diathesis" or from surgical defects resulting in chronic infection, as Boys⁴ suggests, is still unknown. This group represents a serious problem to the surgeon. Many of them have to be, and are, operated upon repeatedly for acute intestinal obstruction. As Hertzler⁴ says: "This sequence lasts as long as the patient does, or the hopeful persistence of the surgeon endures." In this class of patients heparin may be the answer and it may not. It seems to offer a better outlook than anything used up to now.

From our experience we agree with the original investigators that: "Until greater experience has been had in clinical application, the use of heparin should be limited to cases of acute partial or complete intestinal obstruction due to adhesions and particularly to cases in which previous operations have been performed for obstruction or repeated threatening attacks. In other words, heparin should be used only in that group of desperate cases in which one is willing to accept the hazard of an insufficiently tried method in preference to a future risk of significant proportions."

"The one important and essential contraindication is the presence of an oozing peritoneum after adhesions have been divided. Heparin should not be used when granulations or subacute inflammatory tissue is present whether hemostasis seems complete or not."

To this we would add that the time following an abdominal operation, when with safety the abdomen may be reopened, adhesions separated, and heparin used, should not be less than two months. Furthermore, we would not use heparin in the abdomen in those patients where the obstruction was due to a single band of adhesions even though the patient had had repeated episodes of obstruction.

We do not think accidental opening of the bowel during the dissection is a contraindication, as this happened to several of our patients without untoward effect.

The technic of administration as used by Lehman and Boys³ is as follows: After the operation for division of adhesions is completed a Pezzar catheter is introduced into the abdomen through a stab wound in the area nearest the maximum number of adhesions. The abdomen is closed and 10,000 units of heparin* in 300 cc. of normal saline solution is instilled through the catheter which is then clamped and the patient returned to bed.

Blood counts, coagulation time (by the capillary tube method), and blood pressure readings are taken every two hours for six hours, in addition to the usual readings of temperature, pulse and respiration. Coagula-

*Lehman and Boys used heparin from the Connaught Laboratories of the University of Toronto and liquaemin made by Hoffmann-LaRoche, Inc. We have used the Lederle preparation in 10 cc. vials containing 1,000 units per cc.

tion time is longest two hours after heparin is given, when the concentration reaches its maximum in the blood. These readings are taken again just before the introduction of each dose of heparin. Every 12 hours after the operation a dose of 5,000 units in 300 cc. normal saline is instilled through the catheter until 40,000 units have been administered during a period of three and one-half days. The catheter is withdrawn six hours after the last instillation.

They repeatedly assert the necessity for discontinuing the heparin and giving transfusions of whole blood should clinical or laboratory signs of bleeding occur, as the action of heparin is quickly neutralized by protamine of the blood.

In Lehman and Boys' series of 14 cases, they have had 11 smooth post-operative recoveries. One death they attribute to insufficient observation and failure to give transfusions. Autopsy showed this death was due to intra-abdominal hemorrhage of diffuse indeterminate origin. The maximum coagulation time was seven minutes. This patient was operated upon and adhesions separated, obstruction relieved, and heparin given just 15 days after resection of two feet of small bowel had been performed for the relief of obstruction due to volvulus. Apparently the volvulus was caused by adhesions formed at the time of a pelvic celiotomy four years previously. The authors believe the recent operation 15 days before should have contraindicated the use of heparin in this case. One patient had a rather severe toxic (?) reaction from doubtful heparin; one patient had symptoms suggesting hemorrhage, and one had slight wound bleeding. There were no cases of wound disruption, only one had slight pain during administration of the drug, and only one had slight ileus. One, Case 8, developed a pelvic abscess, requiring vaginal drainage, and infection of the abdominal wound. An analysis of their 14 cases is adapted in Table I from their report.

They point out in their conclusions that hemorrhage will always be a potential danger; that this danger can be circumvented by proper clinical and laboratory observations; and that no data have yet been presented to show the effectiveness of the method in preventing adhesions in the human being.

In our seven cases we have modified the technic of administering the heparin after the first operating room dose by giving 10,000 units every 12 hours until a total of 40,000 units has been given. Thus, the total is the same but it is delivered over a period of 36 hours instead of the three days and a half required when 5,000 units are given every 12 hours. We have done this because we have assumed that most of the peritoneal exudate was poured out during the first 24 hours after the operation. We have also carried out our usual treatment following abdominal operations and have given prostigmine 1 cc. of a $\frac{1}{2000}$ solution subcutaneously every four hours for eight doses and then every six hours for eight doses accompanied by the insertion of a rectal tube for half an hour or longer at each injection.

HEPARIN IN THE ABDOMEN

TABLE I
Lehman and Boys

Race	Sex	Age	Surgeon	Prev. Laps.	Prev. Obs.	Heparin Used	Technic	Max. Cg. Time	Post-Op. Course	Complications	Last Seen Post-Op.
1. C.	M.	44	L. & B.	0	0	Connaught	One dose 1,000 u.		Ileus	0	8 days
2. C.	M.	34	L. & B.	2	1	Connaught	Standard	6 m.	Smooth	0	4 mos.
3. C.	F.	51	L. & B.	1	0	Connaught	Standard	7 m.	Smooth	0	2 mos.
4. W.	M.	53	L. & B.	1	1	Connaught	Standard	7 m.	Smooth	Mild bron. pneum.	13 days
5. W.	M.	60	L. & B.	2	1	Connaught	Standard	5 m.	Smooth	0	14 days
6. C.	F.	34	L. & B.	2	1	Connaught	20,000 u. 3 doses	7 m.	Died	Hemor-rhage	2 days
7. C.	M.	65	L. & B.	1	1	Connaught	15,000 u. 2 doses	5 m.	Smooth	Hemor-rhage?	14 days
8. W.	F.	40	Firor	Numerous	Sever-al	Connaught	40,000 u. 4 doses	Normal	Smooth	Slight wd. hem.	6 mos.
9. W.	F.	45	Owings	4	2	Toxic brand	15,000 u. 1 dose	3½ m.	Severe toxic (?) react.		6½ mos
10. W.	F.	60	Freed	11	Num.	Connaught	Standard		Smooth	0	1 mo.
11. W.	F.	Ad.	Freed	1	?	Connaught	Standard		Smooth	0	
12. W.	F.	42	Horsley G.	2	1	Connaught	10,000 u. 1 dose		Smooth	0	21 days
13. W.	F.	46	Horsley, J. S.	1	?	Connaught	30,000 u. 5 doses		Smooth	Slight pair	
14. W.	F.	32	Horsley, G.	1	?	Liquaemin	15,000 u. 3 doses		Smooth	0	

TABLE II

Race	Sex	Age	Prev. Laps.	Prev. Obs.	Heparin Used	Technic	Max. Ven. Cg. Time	Post-Op. Course	Complications	Last Seen Post-Op.
1. W.	F.	44	1	Numerous	Lederle	40,000 u. 4 doses, 36 hours	22 m.	Smooth	Mild wd. bleeding	2½ years
2. W.	M.	54	2	2	Lederle	50,000 u. 5 doses 48 hours	13 m.	Stormy	Failure of healing. Hernia	2 1-3 yrs.
3. W.	F.	45	1	1	Lederle	40,000 u. 4 doses 36 hours	8 m.	Stormy	Ileus	11 mos. after 2nd op. Pain. No obstruc.
3. 1st op.				typh. perit. age 9						
3. 2nd op. 16 m. later			2	2	Lederle	40,000 u. 36 hours	10 m.	Stormy	Wound infect.	
4. W.	F.	25	3	2	Lederle	Same	7 m.	Stormy	Hem. III Pelvic abscess	1½ mos.
5. W.	F.	33	1	3	Lederle	Same	40 m.	Stormy	Hem. II Abd. wall abscess	1½ mos.
6. W.	F.	36	2	2	Lederle	Same	8 m.	Smooth	Slight ileus	4 mos.
7. W.	M.	52	2	4	Lederle	Same	8 m.	Stormy	Ileus	2 mos.

CASE REPORTS

Case 1.—Mrs. E. B., white, age 44, was admitted to St. Joseph's Hospital, November 5, 1941, complaining of pain and cramping in abdomen. She had had the uterus and appendix removed in 1929, and had had repeated attacks, two or three times each month, of abdominal pain and cramping since, usually accompanied by nausea and vomiting. Except for chronic constipation she had been comfortable between attacks. There was moderate distention on admission. She was relieved by a Wangenstein tube, and left the hospital on November 14. She was advised to return for operation for release of adhesions. She was readmitted January 7, 1942, having had several "mild"

attacks in the interim. The blood count, pressure, and venous coagulation time were normal.

Operation.—January 8, 1942: Many adhesions were separated, and in freeing the small bowel from dense adhesions in the right pelvis the lumen was accidentally opened. There was no gross soiling from this. After repair with "intestinal" catgut, the dissection was completed and heparin 10,000 units (Lederle) in 300 cc. normal saline was introduced by the method of Lehman and Boys. Thereafter 10,000 units was introduced every 12 hours for three doses—total 40,000 units. There was slight abdominal distention but no nasal gastric tube was required. There was some bleeding from the incision and around the tube, but the blood count remained above 4,000,000 and the hemoglobin above 75 per cent. The maximum pulse rate was 110; the systolic pressure was never below 120. The maximum venous coagulation time was 22 minutes. This occurred two hours after the second 10,000 units was given, i.e., 14 hours after operation. It returned to a normal six minutes four days after operation. She made a smooth convalescence and left the hospital January 24, 1942. She has been seen several times since, the last time in July, 1944. She has had no further attacks, and has been free from pain.

COMMENT: This case needs no comment except to call attention to the fact that opening the bowel during dissection did not lead to any unfavorable result in the presence of heparin. This was predicted by Lehman and Boys¹ on the basis of their experimental work.

Case 2.—E. P., white, male, age 54, was admitted to St. Joseph's Hospital, March 8, 1942, with abdominal pain, cramping, vomiting, and distention of 24 hours' duration. He had had his appendix removed in 1932 and, in 1936, had had an operation for acute intestinal obstruction. Adhesions were separated but no bowel was removed. He had been well until two days before the present admission. He was relieved by enemata and was feeling well on the third day. Roentgenologic study of the colon showed no abnormality and he was dismissed one week after this admission. He was readmitted, April 2, 1942, with obstruction of less than 24 hours' duration. This was, again, relieved by enemata and, at his request, operation was performed.

Operation.—April 4, 1942: The adhesions were so widespread throughout the right lower abdomen and in the pelvis that an hour was required to free the small bowel everywhere from surrounding structures and from other loops of small bowel. No attempt was made to separate adhesions between the cecum and abdominal wall. Because of the extent of the adhesions this man was given 10,000 units of heparin every 12 hours until 50,000 units were given. He had moderate distention, looked sick, and a Wangenstein negative pressure gastric tube was kept in place for four days. His pressure, pulse rate, and temperature remained within normal limits. His abdominal dressings were saturated with serosanguineous drainage but there was no free bleeding. His maximum venous coagulation time was 13 minutes two hours after operation but did not exceed seven minutes thereafter. On the eighth postoperative day the wound looked good, the sutures were removed, and immediately the wound separated down to the peritoneum which remained intact. There was no gross evidence of infection in the wound. The abdomen was strapped firmly and the wound healed slowly by second intention. He was dismissed May 3, 1942. He returned for repair of a large incisional hernia on December 3, 1942, and we had the opportunity of exploring his abdomen. No adhesions could be found except those between the cecum and anterior abdominal wall which had not been cut at the time of his heparinization. He was repaired with interrupted sutures of cotton. This time he did well until he developed a slight cough and his hernia recurred through the upper half of the incision. As the skin was holding well it was thought best not to repair the rupture again at this time. This was

HEPARIN IN THE ABDOMEN

done successfully June 12, 1943. He was seen last without symptoms and without hernia in August, 1944.

COMMENT: This patient is interesting because his is the first case we know of where there has been an opportunity to study effect of heparin on the reformation of adhesions in the human abdomen. It is quite possible that the large amount of heparin, 50,000 units, was the causative factor in the failure of his wound to heal.

Case 3.—Mrs. H. A., white, age 45, was admitted to the Good Samaritan Hospital, April 8, 1942, complaining of repeated attacks of pain in the abdomen. These were sometimes accompanied by nausea and vomiting, were always cramp-like, and ordinarily lasted for only a few hours. She had had typhoid fever with peritonitis (perforation?) at the age of nine. There had been vague abdominal pain for many years but no severe attack until 1936. She had been married 21 years but never pregnant. In 1937, she had been operated upon for intestinal obstruction, but adhesions were found so universal and dense that nothing much was done. Between this and the present admission there were several episodes of intestinal obstruction, but our operation on April 14, 1942, was performed when obstruction was not present.

Operation.—The small bowel, densely adherent to the anterior abdominal wall, was accidentally opened at the beginning of the operation. After working for two hours, the right lower quadrant was cleared by sharp dissection and the usual heparin treatment was begun until she had received 40,000 units in 36 hours. She had a stormy course and there was considerable distention. There was thin blood-stained drainage from the incision and around the catheter but no evidence of significant hemorrhage. The maximum coagulation time was eight minutes. She was dismissed on the 15th day after the operation.

She was greatly improved, though she had some pain, until another attack of obstruction occurred in August, 1943. We undertook our second operation September 29, 1943, again, when no obstruction was present.

Operation.—September 29, 1943: This time, because the recent pain had been in the upper abdomen, we made a high right rectus incision. Universal dense adhesions were encountered. The liver was fused with the subphrenic peritoneum. The intestine in the right lower abdomen, which had been released 17 months before, was free, mobile, and smooth, without adhesions. Again, the procedure lasted more than two hours and the small bowel was entered three times in the dissection. Heparin, 40,000 units, was given as before.

Her course was again stormy and an abscess in the lower half of the incision did not prove serious. The maximum coagulation time was seven minutes. She left the hospital on the 18th day. When last seen, months later, she was greatly improved, and though there had been some pain there had been no obstruction. She felt that "her operations had been worth while."

This was the second, and only other time, we have had the chance to see the effects of heparin on the reformation of peritoneal adhesions. The contrast between the previously "cleared area" and the thick jungle of adhesions elsewhere was striking.

Case 4.—Mrs. L. H., white, age 25, was admitted to the Good Samaritan Hospital, September 13, 1942, having two days before recovered from pain in the abdomen, vomiting, and distention of 24 hours' duration. She had had an abdominal tumor removed

at the age of 13, an "acute appendix" removed in September, 1941, and an operation for acute intestinal obstruction in December, 1941.

Operation.—September 18, 1942: This was performed with the patient in good condition and no obstruction present. The small bowel was adherent to the right broad ligament, where an ovary had been removed. This was separated, leaving a raw area in its serosa three inches long. Heparin was given, 40,000 units in 36 hours. On the day following the operation she looked sick, there was moderate distention, temperature 101° F., pulse 116. The hemoglobin had fallen to 69 from 89 per cent before operation; the red cells from 4.4 million to 3.5 million. The blood pressure did not fall below 110. The coagulation time was six minutes. We felt that she was bleeding but that our margin of safety was still wide. We continued the heparin treatment and withheld blood. The temperature continued from 100° to 102° F., the hemoglobin and red cells continued to fall, but the blood pressure and general condition remained about the same and the abdominal distention was less. On the third postoperative day, 36 hours after the last 10,000 units of heparin, the red cells were 3 million, the hemoglobin 42 per cent. Daily transfusions of 300–500 cc. of blood were given for the next four days. She improved rapidly, though the daily temperature rose above 101° F.

On the 15th postoperative day a pelvic abscess was drained through the posterior vaginal fornix. Following this she made a good recovery. The abdominal wound healed well and she left the hospital 26 days after the first operation. She was well one month after leaving the hospital.

COMMENT.—In this case we assumed a big risk to keep from neutralizing the action of the heparin. In this instance the result justified us, but so grave a chance will not be taken again.

Case 5.—Miss R. F., white, female, age 33, was admitted to St. Joseph's Hospital, December 18, 1942, with a story of four or five attacks of severe abdominal pain with vomiting, since a ruptured appendix had been removed in July, 1942. The last attack was two days before admission. After six days, during which the obstruction we thought had been relieved by the Wangenstein tube, the cramping pain continued intermittently, so operation was performed.

Operation.—December 24, 1942: Several loops of small bowel were dissected from the pelvis, one completely obstructed but not strangulated. Ten thousand units of heparin was instilled every 12 hours for four doses. The patient was distended the following day, the coagulation time was 40 minutes and the hemoglobin had dropped to 69 per cent from the preoperative figure of 81 per cent. She was given 400 cc. of blood and the heparin treatment was continued. She remained somewhat distended, the temperature ranged from 100° to 101° F., pulse maximum 120. The blood pressure was never below 115. There was the usual serosanguineous drainage from the wound. Following the transfusion the coagulation time fell to 11 minutes and was never above 12 minutes during the heparin treatment. It returned to six minutes two days after heparin was stopped. On the 10th postoperative day the stab wound in the right lower abdomen looked angry. It was opened and an ounce of pus obtained. Two days later the incision showed an abscess which was similarly opened. These places continued to drain and she gradually regained strength. After three more blood transfusions she left the hospital February 13, 1943. She was last heard from six weeks later, and seemed to be entirely well.

This case illustrates, again, the danger of hemorrhage and the possibility of wound infection.

Case 6.—Mrs. J. M., white, age 36, was admitted to the Good Samaritan Hospital May 4, 1944. Her appendix had been removed in 1939, and both tubes and left ovary

HEPARIN IN THE ABDOMEN

taken out in 1941. For three months prior to the present admission she had had cramping abdominal pain with nausea and vomiting. The last of these attacks was two weeks before the present admission and continued for eight or ten hours.

Operation.—May 5, 1944: A single loop of ileum was released from the back of the uterus and right ovary, a posterior round ligament plication done to cover the raw area on the uterus. Forty thousand units of heparin was given in the usual manner. Her convalescence was smooth in every way. The maximum coagulation time was eight minutes. She was dismissed on the 16th day after the operation. In September, 1944, she was well and had had no further trouble.

This case was satisfactory, but the very limited extent of the adhesions did not justify the use of heparin.

Case 7.—A white male, age 52, was admitted to the Good Samaritan Hospital with acute obstruction of four hours' duration. His appendix was removed in 1936. He began to have attacks of obstruction in 1937 and was operated upon for this in 1941. He does not know just what was done at this operation. Because his condition was good, the obstruction had been present less than six hours and distention was only beginning, we operated upon him as soon as he was admitted.

Operation.—There were many adhesions between the ileum and anterior wall and several loops were involved. There was complete obstruction at one point due to one thick band around which the loop of bowel had become angulated. Forty thousand units of heparin were given in the usual manner. His course was uncomfortable, due to distention, there was the usual profuse thin bloody discharge around the tube and from the incision but no signs of hemorrhage. The maximum coagulation time was eight minutes. He left the hospital on the 15th day after the operation. When seen November 15, 1944, he was having no trouble.

COMMENT: This was an ideal case for the use of heparin and, though he was quite uncomfortable for four days, his result so far has completely justified the treatment.

No worthy conclusions can be drawn from seven cases. The original investigators point out that there must be many hundreds of cases coming to autopsy or subsequent operation in which heparin has been used before a real knowledge of its usefulness can be obtained. While this may be true, we think that the clinical test is easier of fulfillment and more satisfactory practically. If it can be shown that large numbers of people with repeated attacks of, and operations for, intestinal obstruction, who have had no relief from surgery, have been set free by heparin, then we can afford to accept it without waiting for the operating room and necropsy to tell us. Until then the whole subject of its clinical application must remain *sub judice*.

It is quite likely that intravenous administration of the drug in much smaller quantity will be as effective as the intra-abdominal route—with less peritoneal reaction.

On account of the edema and congestion in the wall of an obstructed loop of bowel it is probably safer to limit the use of heparin to the interval between attacks of obstruction. We believe the drug should not be used when resection is undertaken, though accidental opening of the bowel as we have

definitely shown, is not a contraindication. The use of the drug should certainly be limited to those people who have had one or more episodes of obstruction, and it is in no sense a prophylactic reagent in routine abdominal surgery.

In our small series those patients who have been followed for more than a year, all of whom have had one or more attacks of obstruction, have been completely relieved.

CONCLUSIONS

1. Intra-abdominal heparin to prevent obstructing adhesions should be limited to those who have had one or more operations for obstruction or repeated attacks following abdominal surgery.

2. The hazards are hemorrhage, infection, and possibly delay in wound healing.

3. The contra-indications to its use are recent abdominal surgery, incomplete hemostasis, and possibly intestinal resection.

4. The hazards should be recognized promptly when they appear, and can be checked by blood transfusion.

5. Red cell and hemoglobin determinations, blood pressure reading, and the general appearance of the patient are better guides in postheparin treatment than any known coagulation time tests.

6. Accidental opening of the bowel during the dissection of adhesions is *not* a contraindication for heparin administration.

7. In our small series we have been pleased with the complete absence of obstruction in the months and years following the use of heparin in the abdomen.

8. Until there are more clinical reports we must consider the use of heparin to prevent "obstructing" adhesions as promising but unsettled.

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DISCUSSION.—DR. E. P. LEHMAN, University, Va.: I have been greatly interested in this paper, as I have a considerable personal stake in the method. I like very much Doctor Massie's conservatism in stating the absence of definite conclusions to be drawn from the clinical material now available. The method has sufficient potential danger so that it must be limited to those cases of repeated operation for obstruction in which one is willing to run a risk for the sake of much needed relief.

Recently, at the University Hospital, we have seen no cases in which we felt the method to be justified, either because there had not been repeated obstructions, or because hemostasis was incomplete. I, therefore, have nothing to add from the clinical angle on the use of this procedure.

I was particularly interested in the two cases in which Doctor Massie demonstrated at a second operation the absence of adhesions in the area treated. I had rather hoped that a larger number of surgeons would interest themselves in this method, because

HEPARIN IN THE ABDOMEN

I have felt and still feel it has promise. The experimental results have been consistently conclusive. I hope we will hear more of it in the future, and thank Doctor Massie for keeping the subject alive.

DR. WALLER O. BULLOCK, Lexington, Ky.: I had the opportunity to observe some of these cases of Doctor Massie's, and I was impressed with the gravity of the conditions they present. Usually a surgeon does not consider with a friendly eye disruption of wounds and postoperative hemorrhage, yet these complications were present in several of Doctor Massie's patients. However, the fact that he has shown that the adhesions have disappeared from the field of operation, make me satisfied that the method has some good, and when the bugs get worked out of it, as they say about machinery, it will prove a useful agency in such cases.

DR. FRANCIS M. MASSIE, Lexington, Ky. (closing): The drug is expensive; it costs about \$5.75 for 10,000 units, and that may limit its usefulness.

I do not know whether or not it is any good. I have used it in seven cases in three years in which I thought it was applicable. I think it is the most promising thing we have had.

I believe concentrating the drug in 36 hours instead of three and one-half days has increased the postoperative risk, but has tended to reduce the adhesions which have reformed.

METHODS OF CONSTRUCTING A VAGINA*

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AN UNUSUAL FEATURE of this report is that four different methods, determined by pertinent circumstances, were utilized to construct vaginas in four women in whom that organ was congenitally absent. Other surgeons have described their results in these cases, but in most instances, each surgeon has recommended only one form of treatment which he has used on all the women under his care. My experience would indicate that several different methods can, if properly used, be equally effective. The choice of methods should be based not only on the anatomic findings present, but also on the temperament, the marital status, the intelligence and cooperation of the woman one is treating.

In my fourth, or most recent case, the flap used to cover the posterior wall of the vagina was made in a way, which, so far as I can find out, has not been described previously, although probably the same technic has been employed by others. Except for this one operative step, there is nothing new in the methods of treatment used in my four cases.

No detailed description of the embryologic defects which result in a woman being born without a vagina will be presented. It will suffice to point out that all the women I treated showed the typical findings which are seen when the lower ends of the two müllerian ducts fail to develop. The only vestiges of a vagina were shallow depressions in the perineum not over 1-1.5 cm. in depth. These represent merely the small terminal portion of the vagina which develops from the urogenital sinus in connection with the external genitalia and does not arise from the müllerian ducts. In my cases, in which the abdomen was opened, small uteri varying from 2-2.5 cm. in length were found—not only in size, but in general development so immature as to make it impossible for them to function, no matter how much hormone therapy might be used. The ovaries, on the other hand, appeared normal. None of the four women showed any signs of hermaphroditism.

Before attempting to make a vagina, a surgeon will want to know the normal dimension of that organ. Most authorities stress the fact that the anterior wall is shorter than the posterior because the vagina is united to the uterus at an acute angle. According to Williams' textbook, the length of the anterior wall varies from 6 to 8 cm. while that of the posterior from 7 to 10 cm. Curtis gives 6.5 cm. as the length of the anterior wall, and 8 cm. as that of the posterior. Wharton writes that the normal adult vagina is about 8 or 9 cm. deep.

What is perhaps more important than the measurements of the normal

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CONSTRUCTION OF A VAGINA

vagina is what length and circumference are necessary for the completion of the sex act satisfactorily both for the woman and her husband. This will, of course, vary to some extent with the husband, but it is certain that in many instances a vagina considerably shorter than the normal length permits satisfactory marital relations. I recently examined a woman whose vagina measured only 5 cm. in length, and she had never suffered from dyspareunia, and regularly experienced orgasm. Her husband, who is apparently a normal man, states that sexual relations are entirely satisfactory to him. The patient has never menstruated, and she has a very small uterus which does not connect with the vagina.

In March, 1935, I saw the first patient of this series. She was then 15 years old and had been married three months. Repeated attempts at sexual relations had been unsuccessful. She had never menstruated. The breasts were well developed. The pubic hair showed typical feminine distribution. On palpation, definite tenderness over McBurney's point on the right was elicited and the patient gave a history of having had several attacks of acute appendicitis. Inspection of the external genitalia showed a normal, but not an hypertrophied clitoris. The labia majora were normal. The labia minora were unusually long and pendulous—something that is occasionally seen in women who are otherwise normal. At the usual site for the vaginal orifice, there was a small opening which would just admit the tip of a Kelly clamp for a distance of only 1 cm. There was no cervix to be felt or seen in this depression. On rectal examination, a small uterus was felt. Normally developed ovaries were palpated.

Because of the repeated attacks of appendicitis, a celiotomy was performed. This gave us an opportunity to inspect the pelvic organs. The uterus was normal in contour, but only 2.5 cm. in length. The fallopian tubes were rudimentary. The ovaries were normal, the right showing a moderately well developed graafian follicle. The appendix was removed, and the patient was then placed in the perineal position. A circular incision was made around the outer margin of the mucous membrane surrounding the perineal depression, following the line where the skin and mucous membrane meet. By blunt dissection, the tissue under the mucous membrane was spread apart. Then, in the same manner, the tissue laterally, anteriorly and posteriorly were all gradually stretched until finally there was a tunnel 7 cm. in length and of sufficient diameter to admit two fingers. The small circular bit of mucous membrane which had originally covered the very immature vagina had been pushed further and further upward while this was being done, so that it finally rested on and covered the top of the newly made vagina. However, all the rest of this 7 cm. long tube was raw and covered with neither mucous membrane nor skin.

Using a method similar to, but not exactly like, the method described by Graves, and later by Davis and Cron, the following attempt was made to cover over these raw areas. The labia minora were dissected off from above downward in such a way as to leave pedicles large enough to furnish good

circulation. The available mucous membrane in each flap was increased by splitting apart from below the surfaces of each labium minus, thus, converting the large folds into flat surfaces. These flaps were then sewed deeply into the vagina with No. 0 chromic catgut. The raw areas left by dissecting away the labia minora were then covered by sewing together the adjacent skin surfaces with interrupted sutures of plain catgut. Care was taken, both in making these flaps and later in covering all the raw areas, not to injure in any way, or encroach too closely on, the clitoris.

This patient was fortunate in having unusually long labia minora, for by using them, as just described, it was possible to cover over the entire lateral and most of the anterior and posterior walls of the newly constructed vagina. Usually, all that can be done with the labia minora is to cover over the lower part of the lateral walls, as the small lips are seldom long enough to stretch beyond this, no matter how the pedicles are cut.

At the time (1935) that this operation was performed, Wharton, not having reported his work with the artificial phallus made of balsa wood, I made one of plaster, covered it with a rubber condom, and inserted it into the artificially made vagina, where it was kept for the first ten days of the patient's convalescence. After leaving the hospital, the patient used it every day for three months as a dilator. It was then possible to introduce a full-size speculum into the vagina without causing her any discomfort.

It was impossible to find out immediately after this operation, whether or not it was successful, for the patient, suspecting her husband of contracting gonorrhea while she was in the hospital, refused to permit sexual relations. She obtained a divorce shortly after, stopped using any dilator, and left the city. Two years later, she remarried and wrote me that marital relations were entirely satisfactory. She was having no dyspareunia and experienced orgasm. One year later, while in Baltimore, she came to my office. The vagina still easily admitted two fingers, was 7 cm. in length, and permitted the introduction of a full-size speculum.

In this case, the unusually long labia minora and the patient's youth were factors that doubtless helped in obtaining a good result. It is worth emphasizing that even though the patient went two years after the operation without using any dilator, the vagina did not contract, as it so often does if dilatations are discontinued. It measured 7 cm. in length at the end of that time, and easily admitted two fingers.

In the second case, an operation was refused. This refusal came not from the patient, but from the man to whom she had been engaged for many years, and later married. He would not consent to his fiancée being subjected to the risk of an operation no matter how slight the danger might be. Knowing Frank's and also Holme's successes in making a vagina without an operation, I decided to try Frank's method.

This patient, an unusually attractive woman, age 21, was referred to me by Dr. Leslie Gay. She was, at that time, a student nurse. The general examination was negative. The breasts were normally developed. The labia

CONSTRUCTION OF A VAGINA

majora and the labia minora were normal. The urethra was normally developed. Between the urethra and the anus, there was not even a dimple to indicate where the vagina should be. On rectal examination, a mass about 2 cm. in length was palpated which the examiner thought was probably the uterus. One ovary was definitely felt.

The patient was given a pyrex glass rod $\frac{5}{16}$ of an inch in diameter, and told to press with this rod on the perineum over an area midway between the urethra and anus. At first, pressure was directed mostly backward, so as to keep from injuring the urethra. The direction of the pressure was changed at the end of a few weeks to upward and backward, following the same axis that the normal vagina takes. This patient was very intelligent and conscientious. She worked with the pyrex tube for at least a half hour, two to three times a day, and reported to my office once or twice a week where I used the tube and my gloved finger, endeavoring to help in producing a vagina.

Progress was slow, but steady. At the end of six weeks, there was an opening which would admit the tip of a finger for a depth of 2 cm. When a little bleeding would occur, as it occasionally would as a result of trauma, the patient stopped treatments for 48 hours. Every night before going to bed, she applied to the perineum, an ointment containing estradiol. This may have been helpful. Certainly its use seemed logical. Six weeks later, the patient was able to introduce the glass rod 4 cm. She was then given a pyrex tube $\frac{5}{8}$ of an inch in diameter. Three months later, or about six months after treatment was started, three fingers could be introduced into the vagina which was now 6 cm. long. The patient married, and has written me stating that sexual relations are entirely satisfactory to both her husband and herself, and has expressed gratitude for what was done for her. She has adopted two children and is very happy.

After reading Frank's article on the production of a vagina without operation, and of learning of Holmes' and my success with this procedure, one might ask why not use this method in all cases. Personally, I think it has marked limitations. This patient treated herself for six months, and the treatments were definitely painful. Only her conscientiousness in carrying them out made success possible. She was never able to wear any of the vaginal forms recommended by others. She tried them, but was unable to sleep with the form in place, and could not carry out her duties as a nurse while wearing one in the day time. When a patient has a small vagina to start with—perhaps measuring 3-4 cm. in length—this method would seem to be the best. Then too, as in this case, it is all that can be tried when an operation is refused. However, I feel that when there is no vagina, or only a dimple 1 cm. in depth, few women would continue these treatments long enough to make the method succeed, and, therefore, in many instances, an operation is preferable.

The third patient was a generally well-developed woman, age 32 who had never menstruated. She did, however, give a history of recurring

attacks of discomfort in the lower abdomen. She thought that perhaps the attacks came at monthly intervals, but she was not certain of this. Later developments in the case indicated that the supposed monthly periodicity of these attacks was probably due to suggestions on the part of the doctors who had examined her. On examination, the breasts were found to be normal. The clitoris and labia majora and labia minora were present and moderately well developed. There was an opening in the perineum just below the external urethra. It was about 1 cm. in depth. Rectal examination showed a large mass of tissue in the pelvis which was fully the size of a normal uterus.

After examining the patient, I suspected that I was dealing with an entirely different condition than existed in the first two women. It seemed probable that this woman had a normally developed uterus which, as suggested by the monthly attacks of pain, menstruated and that the blood could not be discharged because of the absence of a vagina. The patient was told that there was a possibility that a vagina could be made and connected with her uterus so that she not only might have sexual relations, but might possibly menstruate and even conceive. This patient had been examined by several doctors before I saw her, and the consensus of opinion was that the mass palpated through the rectum was an enlarged uterus. However, permission was obtained to perform a celiotomy if indicated—which should always be done when one operates upon a patient with this condition.

I decided to follow the technic recommended by Wharton, in which an incision is made in the perineum, the tissues dissected by blunt dissection until a tunnel is produced, after which a vaginal form is introduced into this cavity. No attempt is made by plastic surgery to cover the newly formed cavity with epithelium as was done in my first case. In carrying out the Wharton operation on this patient, I made my dissection upward slowly until only about 1 cm. separated the top of the newly made vagina from the large mass which I had felt on rectal examination, and which up to that time I had thought to be the uterus. This dissection upward was carried out until a vagina 7 cm. in length had been made. At this point, I thought it wiser to make a lower abdominal incision and actually see the condition in the pelvis before burrowing further upward from below.

After making this incision, I was surprised to see that what I had thought was the uterus was the patient's only kidney. There was no renal tissue in either renal fossa. The pelvic kidney was one-half again the size of a normal kidney. One ureter could be felt extending downward on the left side towards the bladder, although the kidney itself was situated just about in the midline over the promontory of the sacrum. No right uréter was seen or palpated. The left ureter and ovary were normal. No right tube or ovary was seen. The uterus measured only 2 cm. in length. There was no Meckel's diverticulum. The appendix was removed and the abdominal incision closed. The patient was again placed in the perineal position and a Wharton-form made of balsa wood was introduced into the newly formed vagina. The

CONSTRUCTION OF A VAGINA

patient remained in the hospital for about two weeks with the form held in place. After leaving the hospital, she continued to wear it for two weeks, and after that, wore it part of the time for three months. When the patient was operated upon, she thought she would marry in the next few months, but later decided to postpone the marriage because of the war. She stopped using the dilator against my advice. Two years later I saw this patient. The vagina was still 7 cm. in length, but the orifice had contracted down so that it would admit only one finger. It was, however, very easy to dilate the orifice under sodium pentothal, so that two fingers could be easily introduced. The patient is now using a vaginal dilator which she can introduce the full length without causing any discomfort. It measures 9 cm. in length, and has a circumference of 11.5 cm. When she marries she will have no dyspareunia.

In this case, there were embryologic defects in both the generative and urologic systems. It has been pointed out by several writers that when there is a defect in one of these two systems, one should be on guard for abnormalities in the other. In spite of this, I mistook, at least temporarily, the patient's only kidney for an enlarged uterus. If I had not recognized while operating, that I was dealing with something very unusual and had continued my dissection upward from the vagina, there is considerable likelihood that one of the large renal vessels might have been torn, with very serious consequences. In the future, in every case of absence of the vagina, I shall take a routine intravenous pyelogram before operating. In this instance, an intravenous pyelogram was not taken until after the operation. It showed that there were no kidneys in the renal fossae. The patient's only kidney could be seen situated down in the pelvis. It was poorly visualized because the dye drained so rapidly from the kidney into the bladder. One could, however, see quite plainly the left ureter which was not dilated. The patient's urine was negative on examination, and her renal function normal.

The fourth, and most recent, case was that of a 20-year-old girl, referred to me by Dr. Hugh Young. She had never menstruated. Her breasts were normally developed. The distribution of pubic hair was of the masculine type. The clitoris, labia majora and labia minora were normal. There was no sign of hermaphroditism. Just below the urethra there was a small depression 1 cm. in depth.

At an abdominal operation performed by Doctor Young, her uterus was found to be 2.5 cm. in length. The fallopian tubes were small and poorly developed. The ovaries were normal, and one ovary showed a graafian follicle. On palpation through the lower midline incision, Doctor Young found that the left adrenal gland was somewhat larger than normal. Whether this finding has any bearing on the congenital absence of the vagina is, of course, problematic, but it was an interesting finding and suggestive. The appendix was removed, and one week later I performed the following operation:

Operation.—Johns Hopkins Hospital—December 13, 1943: An inverted U-shaped incision was made through the skin, beginning just below the

urethra and extending backward, and slightly laterally, until the dorsal ends of the incision terminated 2 cm. ventrally and laterally to the anus (Fig. 1). This incision was then continued through the subcutaneous fat for about one cm. Then, beginning at the ventral border, the tissue was undercut from above downward, forming a flap whose pedicle was the tissue in front, and just lateral to the anus (Fig. 2).

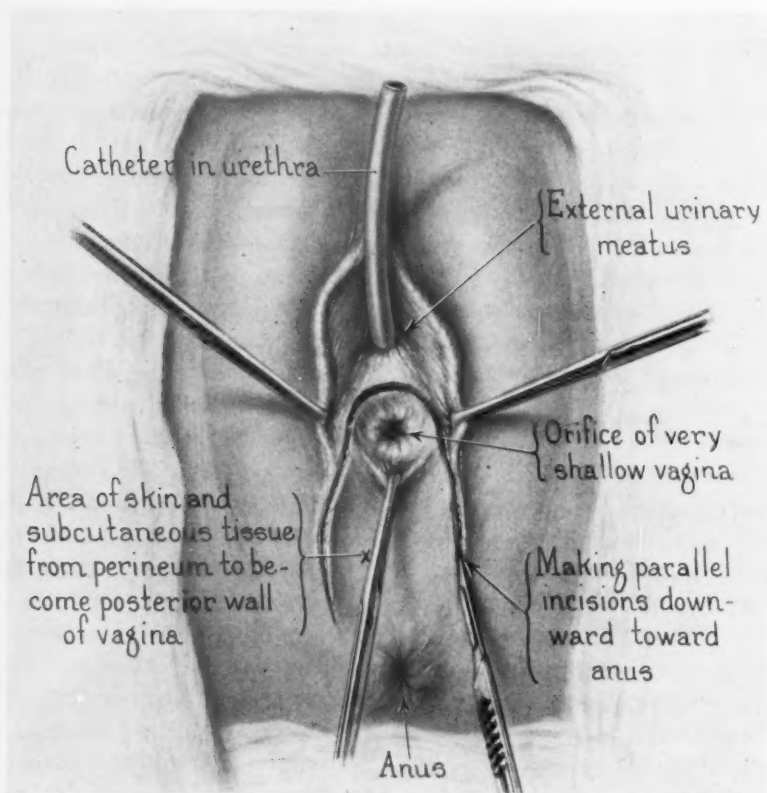


FIG. 1.—An inverted U-shaped incision has been made through the skin beginning just below the urethra and extending backward and slightly laterally until the dorsal ends of the incision terminated 2 cm. ventrally and laterally to the anus.

After turning this flap backward, the fat and subcutaneous tissue under it were carefully separated and stretched by blunt dissection until there was a cavity into which two fingers could be introduced for a distance of 8 cm. In carrying out this dissection, the operator took special care not to come too close to the urethra, bladder or rectum. A retention catheter had been introduced into the bladder, and a rectal tube into the anus before the operation was started and, by means of these, it was possible to tell just how closely the dissection approached the urinary and intestinal tracts. In this case, there was never any danger of the urethra or bladder being injured. However, as the dissection was carried upward, the rectum seemed to be getting nearer and nearer until only a small amount of tissue separated it from the cavity

CONSTRUCTION OF A VAGINA

that was being formed. Because of this, the dissection upward was stopped when the cavity measured 8 cm. There probably is in different cases considerable variation in the extent that the rectum bulges anteriorly toward the space that ordinarily would be occupied by the vagina. In the other women for whom the operator has made vaginas, there was not the danger of injuring the rectum that there was in this case.

Now that a cavity 8 cm. in depth, and of sufficient diameter to admit two fingers, had been dissected out, the steps remaining in the operation were

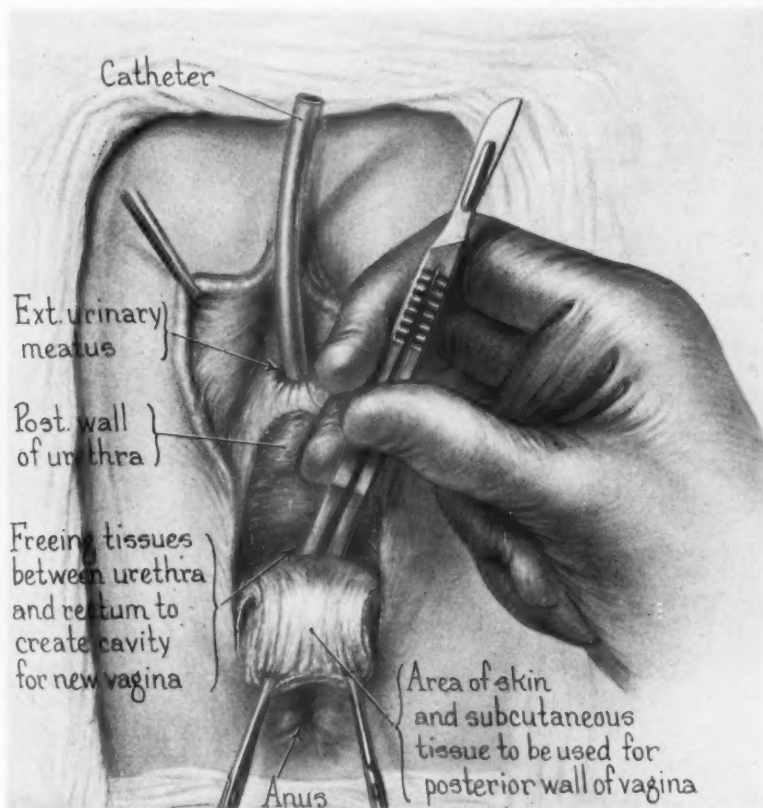


FIG. 2.—The incision shown in Figure 1 has been continued through the subcutaneous fat for about 1 cm. Then, beginning at the ventral border, the tissue has been undercut from above downward, forming a flap whose pedicle is the tissue in front and just lateral to the anus.

those which would cover, as far as possible, this cavity with epithelium and which would prevent its postoperative obliteration through contraction. The first step in accomplishing this was to carry the U-shaped flap of skin and subcutaneous fat which had been made by the original incision deep down into the cavity and sew it to the underlying tissue. No. 0 chromic catgut sutures were used for this fixation (Fig. 3). The operator had never before made a flap to cover the posterior wall of a newly made vagina in just the way done in this case, nor had he read of this procedure in the literature. The

flap measured about 6 cm. in length. By extending the ends of the original incision practically to the anal margin, this flap might have been made 1 or 2 cm. longer.

To cover the anterior and lateral walls of the vagina, the labia minora were dissected off from above downward in such a way as to leave pedicles sufficiently large to furnish good circulation. The available mucous membrane in each flap was increased by splitting apart from below the surfaces

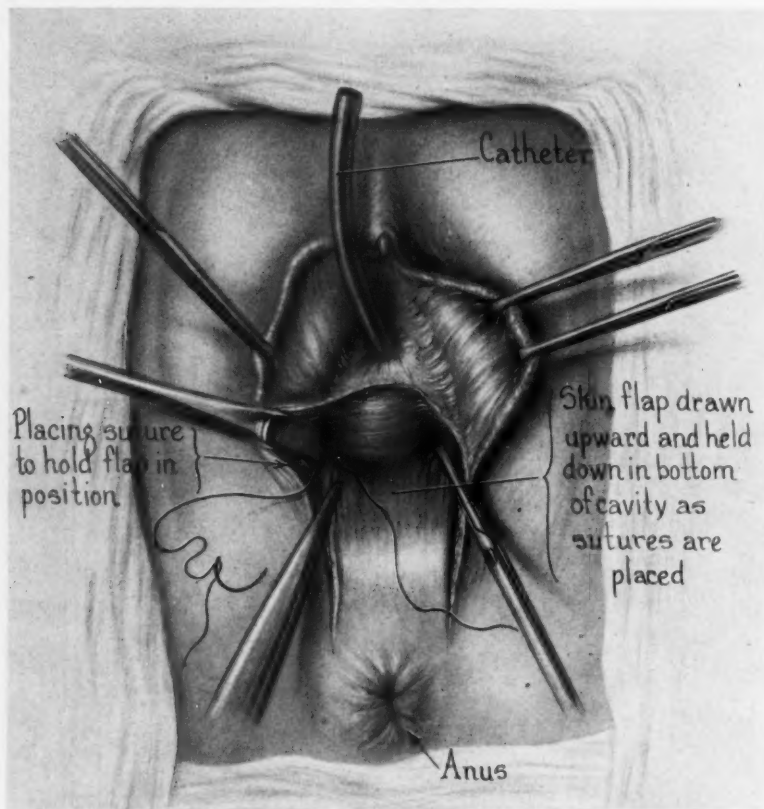


FIG. 3.—The U-shaped flap of the skin and subcutaneous tissue shown in Figure 2 has been carried deep down into the cavity and is being sewed to the underlying tissue.

of each labium minus, thus, converting the large folds into flat surfaces (Fig. 4). These flaps were then sewed deep down into the vagina with zero chromic catgut. The raw areas left by dissecting away the labia minora were then covered by sewing together the adjacent skin surfaces with interrupted sutures of chromic catgut. Care was taken, both in making these flaps and later in covering all the raw areas, not to injure in any way, or encroach too closely on the clitoris.

It was then evident that a vagina, 8 cm. in depth, had been made whose anterior and lateral walls were well covered with epithelium, except for a very narrow area in the anterior midline. The lower two-thirds of the posterior

CONSTRUCTION OF A VAGINA

wall were also covered by an epithelial flap (Fig. 5). The only raw area that remained was in the uppermost part of the posterior wall. To cover this with epithelium, Dr. Edward Hanrahan then cut a midthickness split-graft, measuring 11 x 5 cm., from the right thigh. This graft was sewed over a Wharton "vaginaform" made of balsa wood, then introduced into the vagina in such a way that it was in close contact with the remaining uncovered

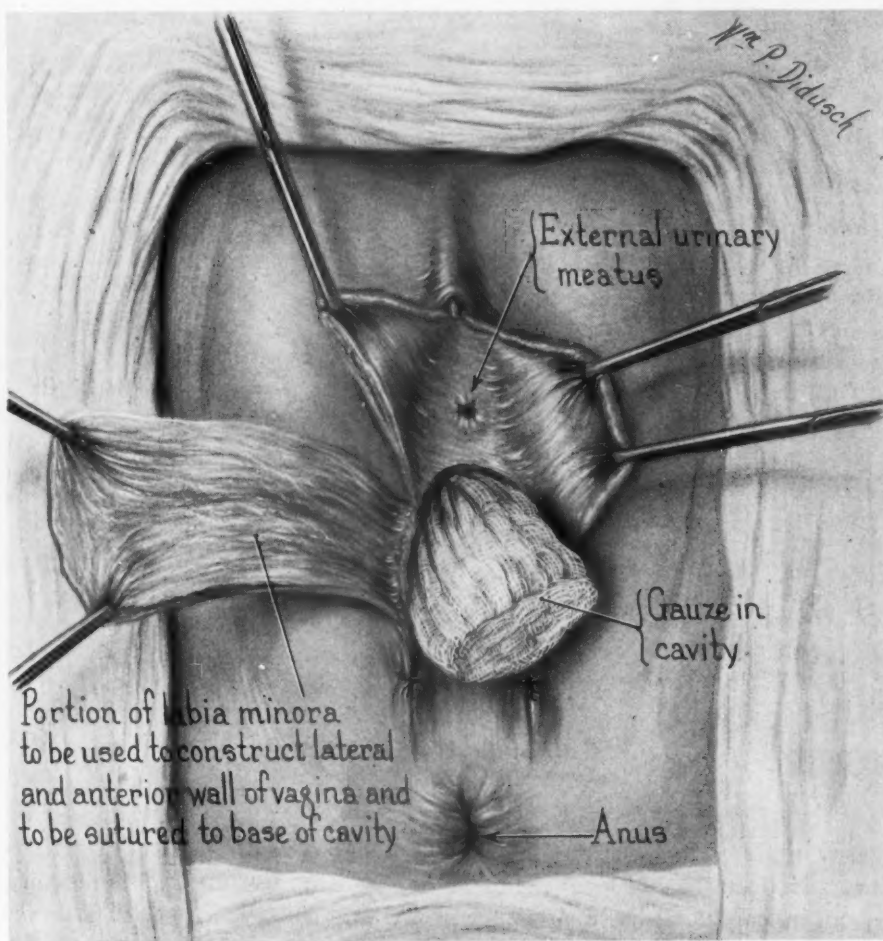


FIG. 4.—The labia minora are dissected off from above downward in such a way as to leave pedicles sufficiently large to furnish good circulation. The available mucous membrane in each flap is increased by splitting apart from below the surfaces from each labium minus, thus, converting the large folds into flat surfaces. On the right is shown the large flap that can be made in this way.

area. A retention catheter was left in the bladder. The patient left the operating room in good condition. There had been very little loss of blood.

The patient's convalescence was satisfactory, although she did complain of the discomfort caused by wearing the "vaginaform," which was removed on the tenth day. It was then evident that the flap made from the skin of the perineum by the converted U-shaped incision had lived, and that it now

covered the lower two-thirds of the newly made vagina. The flaps formed from the labia minora were also living, completely covering the lateral vaginal walls. It was difficult to be certain how much of the graft cut from the right thigh survived, but certainly some of it did. The patient left the hospital on her 12th postoperative day, but remained in the city for a month longer, coming to my office three times a week. On her last visit, the vagina

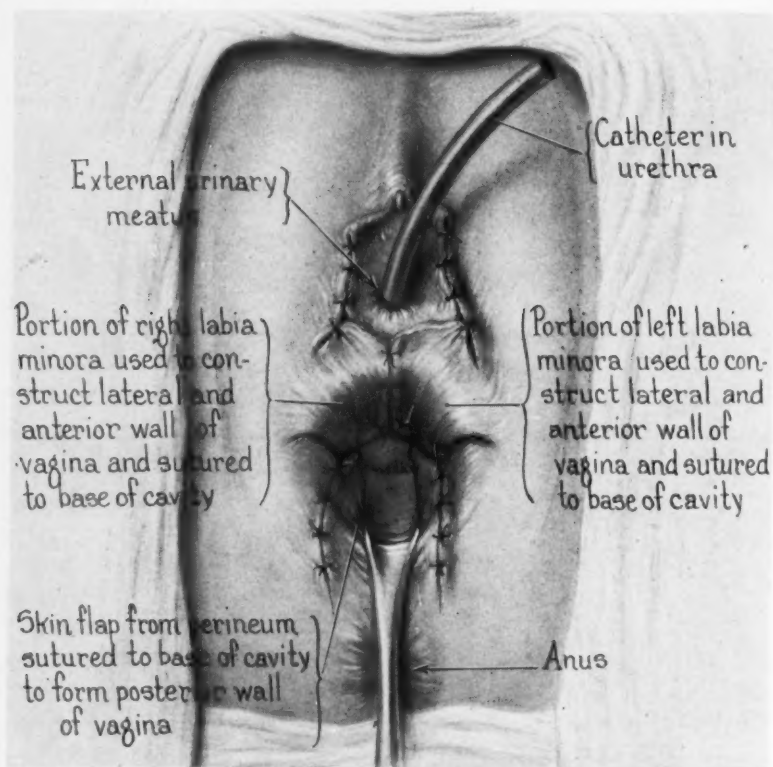


FIG. 5.—A vagina 8 cm. in depth has been made. By using a flap of skin and subcutaneous tissue, practically all of it has been covered with epithelium.

easily admitted two fingers. She is now using a vaginal dilator which she can introduce the full length without causing any discomfort. It measures 9 cm. in length and has a circumference of 11.5 cm. When she marries she will have no dyspareunia.

SUMMARY

Vaginas were made for four women. The method used in each case was different. In the first, the labia minora were unusually long, and by utilizing them, it was possible to cover over most of the newly made vagina with epithelium. In the second case, a vagina which has proven satisfactory for several years was made without any operation. The intelligence and co-operation of this patient played a large part in making this procedure successful. In the third case, the Wharton technic was followed. This

CONSTRUCTION OF A VAGINA

consisted in making an elongated canal in the perineum and keeping that tube open by means of a vaginal form of balsa wood. Following the technic Wharton first recommended, no effort was made to cover the newly made vagina with epithelium. In the fourth case, an extensive plastic operation was performed in which the labia minora were again used to cover over raw areas, but as they were not long, this step was supplemented by using the skin of the perineum between the urethra and anus. This was accomplished by making an inverted U-shaped incision, dissecting out a flap between the urethra and the anus, and sewing this flap deeply into the newly made vagina.

The third case in this series was particularly interesting, as in addition to the embryologic abnormalities of the generative tract, there was also an abnormality of the urologic system. The patient's only kidney was low in the pelvis and was mistaken by several examiners for the uterus. There probably is no one best method of making a vagina. In the writer's opinion, one should take into consideration the anatomic findings, the temperament, intelligence and marital status of a patient.

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SPONTANEOUS PERFORATION OF THE RECTOVAGINAL SEPTUM, FIVE WEEKS AFTER CONSTRUCTION OF THE VAGINA*

CASE REPORTS

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CONSTRUCTION OF THE VAGINA involves the dissection of a large space between the rectum and bladder. This dissection is usually easy, unless operations have been performed in this region before. If there have been former unsuccessful attempts to construct the vagina, the normal plane of cleavage is replaced by dense scar tissue. This makes the dissection extremely difficult and, under these circumstances, injuries of the rectum or bladder have been common and unavoidable. These accidents have occurred during the course of the dissection, in the operating room. In the case herewith reported, however, the perforation occurred 5.5 weeks after a successful operation and convalescence, and was due to the pressure of the strong perineal muscles on the vaginal form which pushed the vaginal form through the vaginal wall into the rectum. This is the first complication of this sort that I have encountered. It is my purpose to analyse the factors that caused this disastrous accident, in the hope that we may, in the future, prevent them.

Case Report.—The patient, age 24, had undergone the vicissitudes that are so often experienced by women who have no vagina or uterus. At the age of 15, because of her failure to menstruate, she had a gynecologic examination. At that time, she was called normal, the amenorrhea was deemed functional, and attributed to the high altitude of Colorado Springs. A shift to low altitude did no good, although the young girl continued to develop normally in every other way. For three years, from the age of 17 to 20, she received hormone injections. When she wanted to get married, at the age of 24, she did not have a premarital examination; she assumed that her menstrual periods would appear after marriage. After her marriage, however, she made the further unfortunate discovery that she could not have coitus. It was not until this time that a careful gynecologic examination was made, which revealed the true state—complete absence of the vagina and uterus.

A few months later, in November, 1943, she came to Baltimore. She was a perfectly normal and healthy young woman whose sole defect lay in the complete nonunion and developmental inhibition of the müllerian ducts, resulting in complete absence of the vagina and uterus. The ovaries and secondary sex characteristics were normal. Since the indication seemed clear, a vagina was constructed using the basic technic I described in 1938. I lined the vaginal space with skin, using a Thiersch graft cut from the thigh. The skin graft was cut by Dr. E. M. Hanrahan. The graft was sewed over the vaginal form. The operation was performed November 11, 1943, at the Johns Hopkins Hospital.

Five and one-half weeks later, after the patient had been out of the hospital for two weeks, she returned for an examination. She was still wearing a vaginal form. The vaginal cavity was 11 cm. deep, large, and completely lined by epithelium except in the vertex. We thought we had accomplished an almost perfect result. At this follow-up examination, I removed the form easily, replacing it by a smaller vaginal form which the patient had worn before with perfect comfort. I was so pleased with the result that I arranged for her to return to the hospital the following morning, when I could demonstrate the result to one of my associates.

* Read before the Fifty-sixth Annual Session of the Southern Surgical Association, December 5-7, 1944, Hot Springs, Va.

VAGINAL CONSTRUCTION

Twelve hours later, during the night, the patient felt a desire to defecate, and in spite of using great pelvic pressure, was unable to do so. She noted the passage of a certain amount of bloody discharge from the vagina, although there was no pain. From her hotel, she called the resident gynecologist who asked her to call me the following morning.

When I examined her the following morning, the form was so high in the vagina that I could just touch it with the index finger. Also, the perineal muscles and vaginal orifice were so strongly contracted that it was impossible to remove the form without an anesthetic. A small amount of sodium pentothal was therefore given, the constrictor

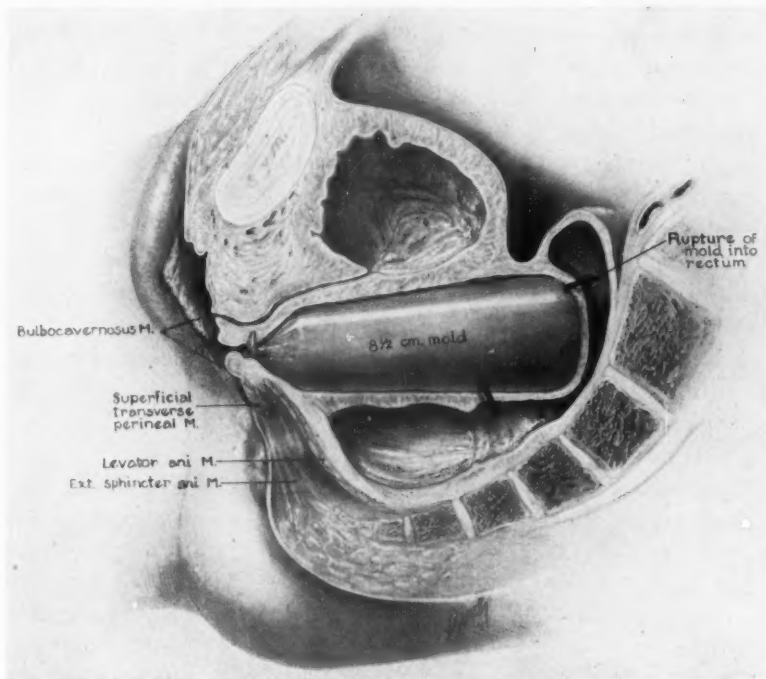


FIG. 1.—The figure shows the position of the form in the constructed vagina. It is not visible from the vaginal orifice. Pressure of the perineal muscles and the pelvic diaphragm is exerted on the end of the form and this may force the form into the rectum or the peritoneal cavity. This illustrates the reason for using a form that is either much shorter than the above or definitely longer.

muscles of the vagina and the proximal fibers of the perineal fascia were cut, and the form removed from the vagina. The apex of the form was seen to be covered with fecal material; it was, therefore, evident that the end of the form had been forced through the rectovaginal septum into the rectum. The opening into the rectum admitted two fingers, and was in the apex of the newly constructed vagina.

The repair of the large rectovaginal fistula immediately became the chief problem, and to cure it, we had to sacrifice part of the vagina which we had so carefully constructed. I inserted a large tube into the rectum, through the anus, and closed the rectovaginal opening over this tube. The fistula was closed very loosely, using only three interrupted sutures of No. 0 chromic catgut. This merely brought the torn edges of the rectovaginal septum into contact with each other, so that they could heal. The vaginal cavity was then irrigated and packed with xeroform gauze.

The subsequent care consisted only of keeping the rectal tube in place for about two weeks, and keeping the vaginal space as clean and open as we could. We allowed the walls of the apex of the vagina to adhere to each other, to close the rectovaginal

fistula. Within six weeks the fistula was closed completely. After this, the vagina was examined every week by me, and dilated every night by the patient, using a form which we gave her. Nine months after the accident, the vagina was seven centimeters deep, admitted three fingers easily, and was everywhere lined by normal epithelium. This provided a vagina about two-thirds as deep as it had been before the accident occurred. But it was a deeper and more commodious vagina than had usually resulted following the employment of other, more complicated operative technics.

COMMENT.—From the above experience, I would draw the following conclusions:

1. The vaginal form should never be so short that it lies completely above the muscular plane of the pelvic diaphragm. In this case, I noted that the vaginal form was so short that it disappeared completely in the large vagina. Hence, any pressure exerted by the pelvic floor was directed against the end of the form and pushed the form higher against the rectum or cul-de-sac of Douglas. One safeguard against this accident would be to have the form long enough to protrude slightly from the vaginal orifice. A form of such length could not be pushed upward by perineal pressure.

2. A second safeguard against this accident would be to make the vaginal orifice so large that it could not close or contract over the end of the form. It should be large enough to allow the form to escape if the intra-pelvic pressure is increased. It should always be easy to reach and remove the vaginal form. The vaginal orifice can be enlarged easily by cutting the constrictor vaginae muscle and the proximal fibers of the perineal fascia. This also prevents dyspareunia later.

3. Constipation is to be avoided. The patient in this report had been constipated. If constipation should develop, the patient should avoid pressure to produce defecation.

4. The method of closure of the fistula was simple. We made no attempt to dissect out the layers of the rectovaginal septum; we only provided a loose approximation of the torn edges, and put the whole region at rest by a large rectal tube. In spite of the unfortunate accident, the ultimate result was not entirely unsuccessful.

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DISCUSSION.—DR. HOWARD MAHORNER, New Orleans, La.: I am interested in these papers because I have had an opportunity to construct artificial vaginas in two women. Doctor Wharton deserves credit for calling attention to the fact that it is possible to construct a vagina by a procedure relatively simple compared to the older methods of intestine transplant. Since I heard his presentation and the description of his method before this Association, I have operated upon two cases. My idea, also, in this discussion is to present a stent which was used on my patients.

In devising the stent two ideas seemed important; one, to obtain a satisfactorily large vagina so that if there was any contraction there would still be ample space; and two, to protect the urethra, which would be endangered by pressure if the stent used was large. I had a machinist construct this stent, which is shaped like a radio tube. In the front of it is a large groove which permits the use of an indwelling catheter in the urethra to remain without fear of pressure necrosis. The stent is six inches long and two

VAGINAL CONSTRUCTION

and one-quarter inches in diameter. In preparing the space at operation I have found the dissection between the rectum and bladder very much like that required in this region for abdomino-perineal resection. One need not be afraid of dissecting very high and of making a huge space. The stent can be worn for a long period of time if necessary.

A split-skin graft was placed on the stent. The take was remarkable (Fig. 1). This is the largest size speculum which after healing is admitted easily; and one could put the fingers into the vagina and by bimanual examination feel them easily just under the abdominal wall. The lower part of the vagina did not heal promptly. Because of this it was necessary for her to wear the stent for months. The lower area was regrafted and shortly after that she was married and found the stent was no longer necessary. She assured me her marital relations were happy in every respect.

Avoidance of scar tissue by early skin graft is important. In the second patient the stent was worn only a short time (three weeks). The stent is connected with rubber bands to an abdominal belt made of canvas.

I am glad to see Doctor Brady's procedure because I think the method may be helpful in preventing contractures at the vaginal outlet.



FIG. 1.—Stent for use in constructing an artificial vagina. A groove cut anteriorly on the stent protects the urethra in which, in the initial postoperative period, is an indwelling catheter. Otherwise, there may be danger of pressure necrosis from so large a stent. Anteroposterior holes at the base of the stent permit rubber tubes to be passed through which are attached to an abdominal girdle. The stent is very large, approximately six inches in length and two and one-quarter inches in diameter. It is shaped like a radio tube. The large size is to insure against contraction. It is covered with a split-thickness graft and inserted into the new space.

DR. LEO BRADY, Baltimore, Md. (closing): I agree that it is usually easy to make as long a vagina as you desire. However, in an occasional case there is danger of getting into trouble. In one of my patients there was no difficulty in keeping away from the bladder and the urethra, but as the dissection was extended upward, the rectum came closer and closer to the operative field. Apparently in different patients, the extent to which the rectum bulges forward into the area normally occupied by the vagina varies considerably.

DR. LAWRENCE R. WHARTON, Baltimore, Md. (closing): I agree with Doctor Mahorner about the grafts. We have used Thiersch grafts in these cases; there is much more rapid healing and scar tissue is abolished. The large outlet I think is important. The operation is useless if the vaginal opening is not satisfactory and ample.

INTERVERTEBRAL DISK LESIONS ARE THE MOST COMMON CAUSE OF LOW BACK PAIN WITH OR WITHOUT SCIATICA*

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SO-CALLED IDIOPATHIC low back pain with or without sciatic radiation is the most frequent condition seen in the adult orthopedic clinic. In spite of the fact that orthopedic surgeons have devoted much time and thought to this condition, the pathologic changes which are responsible for the symptoms are, for the most part, unknown. Consequently, the diagnosis of low back conditions is largely a matter of speculation. Hundreds of articles have been written on the subject and many classifications of low back pain have been offered. Over 20 years ago a diagnostic study of a series of 300 patients whose principal complaint was low back pain or sciatica led me to conclude that the great majority of these patients were suffering from strains of the lumbosacral or sacroiliac joints (Key¹). In spite of the fact that half of these patients were studied in Boston, where the sacro-iliac joint was then at its zenith as a cause of low back pain, the lumbosacral strains were found to outnumber the sacro-iliac strains by over four to one. It was further stated that while about one-third of the patients presented evidence of hypertrophic arthritis in the roentgenogram, the pain was not due to the arthritis *per se*, but was caused by strain.

The patients were classified as follows:

1. Lumbosacral strain of sudden onset (pain predominantly unilateral in the low back and often referred to the superior gluteal and sciatic nerves), 35 to 40 per cent.
2. Lumbosacral strain of gradual onset (pain as in 1), 20 to 25 per cent.
3. Postural type of lumbosacral strain (pain midline and bilateral in the low back and not referred), 20 to 25 per cent.
4. Sacro-iliac strains, 15 to 20 per cent.

It was stated that the pathology of the above conditions was not known, but it was suspected that the lesions of traumatic and gradual lumbosacral strains were true sprains with tearing or stretching of the ligaments or joint capsules and that the referred pains were due to irritation of the nerve roots by synovitis or exudate in the adjacent joints. It was further stated that the prognosis in all of these low back strains was, as a rule, good, but that chronic and recurring cases usually require a longer time for cure.

In the intervening 20 years I have read a considerable part of the voluminous literature on low back pain and sciatica, but until recently I have not been sufficiently impressed to adopt any important changes, either in the classification or methods of treatment outlined in that paper, except that I have grad-

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ually eliminated the sacro-iliac strains. At no time have I accepted the various current explanations of low back pain, such as fascitis, insufficiency of the vertebrae, facet syndromes, instability of the lumbosacral spine, tight fascia lata, fibrositis, sacralized transverse processes and other congenital anomalies in this region: spondylitis, sacro-iliac subluxations, apophyseal subluxations, apophyseal arthritis, ligamentous strains in this area, focal infections, *etc.*

When Barr and Mixter² reported their work on protrusion of the nucleus pulposus, I, like most orthopedic surgeons, agreed that they had discovered the cause of the pain in a small percentage of the patients with low back pain and sciatica, but I was not at all interested in turning my patients over to a neurologic surgeon in order that he might inject lipiodol and search for a filling defect in their spinal canals. What happened to those patients in whom no filling defect was found? In what percentage of the spinograms were the examinations negative? Did these patients develop symptoms caused by the lipiodol? Did patients with protruding disks get well without operation? In vain I watched the literature for answers to these questions and also for convincing reports on the end-results of disk operations.

Our patients with low back pain had been getting along pretty well and the first duty of the physician is to do no harm. Experience had shown us that the great majority of our patients with low back pain, with or without sciatica, either continued their normal activities during the period of pain or were able to resume them after a variable period of conservative treatment at home and the more resistant cases were hospitalized and a very few of these were operated upon as a last resort. But conservative treatment and time were given a chance to effect a cure before surgery was even contemplated. The lipiodol injection and spinogram seemed to me to be a rather formidable procedure and I wanted none of it in my practice.

When Spurling, Dandy, Semmes, Love and other neurologic surgeons began operating upon these patients on the basis of the history and physical examination, I became seriously interested in the subject and learned to perform the operation. As practically all of my disk operations are done under local anesthesia, I soon discovered why orthopedic surgeons had not discovered disk protrusions long ago. It is because they had done little or no work in the spinal canal and did not know or appreciate the significance of the fact that the nerve roots within the canal are exquisitely sensitive as compared with the peripheral nerves. Realization of this fact immediately focuses one's attention on an intraspinal cause when dealing with referred pain and it is found that a relatively slight lesion within the canal can cause severe symptoms.

It soon became evident that the protrusion of the disk was a satisfactory explanation of the symptoms in patients with the typical disk syndrome, but what of all of the other patients with low back pain of varying degree and in whom the pain may be localized in the low back or at times be felt in the buttocks, thigh, leg or foot? If these are not disk lesions, what are they?

Even before I accepted a lesion of an intervertebral disk as a frequent

cause of this condition, I had gradually eliminated sacro-iliac strains as a cause of low back pain and sciatica. This left the traumatic and the postural type of low back pain. Both originate in the lumbosacral area (fourth and fifth lumbar and first sacral vertebra) and may be of sudden or gradual onset and begin with or without known cause. In the traumatic type the pain is predominantly unilateral and also tends to be referred to the buttocks, posterior thigh, calf and even to the toes. In the postural type the pain is in the midline and bilateral in the lumbosacral region and tends not to be referred.

The physical findings in these patients vary directly with the severity of the symptoms present at the time of the examination and all transitions exist between the patient with a complaint of mild unilateral low back pain who is completely negative on physical examination and one with a typical disk syndrome with severe back and sciatic pain, marked muscle spasm and pain on movement, limitation of movement of the back and lower extremities and sensory and reflex changes in the involved lower extremity.

It is further to be noted that the symptoms may vary greatly from time to time and even from day to day and while in some patients the symptoms and signs may persist for weeks or months, in others even 24 hours' rest in bed may produce a marked change in the clinical picture. It, thus, may be possible to trace the various transition stages between the mild unilateral low back pain and the typical disk syndrome in a single patient if he is studied over a period of time and his symptoms become aggravated or subside during the period of observation. Since the above is true, why are not all of these traumatic type of lumbosacral strains due to lesions of an intervertebral disk? No other cause has ever been demonstrated. As is stated above, it is pure speculation to attribute the symptoms to any of the various diagnoses under which these conditions have been treated in the past. A disk lesion is the most logical explanation of the dramatic relief which is sometimes obtained by manipulation of the low back.

The postural type of lumbosacral strain is characterized by a history of pain in the midline and across the low back and this pain is not referred to the lower extremities. On physical examination these patients exhibit tenderness on pressure in the lumbosacral region and the pain is aggravated by hyperextension of the low back. In most instances the symptoms are not very severe and the patients do very well under conservative treatment. However, in an occasional patient with a lumbosacral strain of the postural type operative treatment is advisable and in about 25 such instances I have explored the spinal canal in the lumbosacral region and have found and removed disks which protruded in the midline and in most, if not all, of these the operation was followed by relief of the pain. These cases are similar to those reported by Dandy.³

In the postural type lumbosacral strains also there are all transitions between the mild and the severe cases and it may be possible to follow the changes in a single patient if he is examined at intervals while his symptoms

INTERVERTEBRAL DISK LESIONS

are becoming quiescent or aggravated. If this is true, why are not all of these postural types of lumbosacral strains caused by lesions of an intervertebral disk? Certainly no other cause has been demonstrated. Twenty years ago I wrote vaguely of "irritation of the posterior sacrum caused by pressure of the articular processes of the last lumbar vertebra which in hyperextension glide down over their facets to impinge on the sacrum" (Key¹). This was unsatisfactory then, but nothing better has been offered until we have realized the frequency and significance of lesions of the intervertebral disks. There is no question but that the intervertebral disk is not only subject to degenerative changes, but it is the most vulnerable structure to injury in the low back.

It is, thus, evident that I now believe that in practically all patients with idiopathic low back pain the cause of the pain is within the spinal canal and that in over 90 per cent of the cases this is a lesion of the intervertebral disk. It is probable that in many of the mild cases the back pain originates in the disk itself, because frequently at operation under local anesthesia pain has been produced by pressure on the disk or on the adjacent periosteum or ligament or by manipulating an instrument within the disk and thus moving the adjacent vertebrae. Also, it is significant that in most instances the back pain appears first and the gluteal or sciatic pain begins some days or weeks later or may not appear until after one or more episodes of back pain. It is possible that some of the back pain is due to irritation of the nerve roots and is referred along the posterior primary division of the involved spinal nerve.

The problem of diagnosis, then, is first to determine whether or not the patient's pain originates in the low back. This can be done by the history and physical examination. In my experience if pain in the low back is the dominant symptom the pain is rarely caused by genito-urinary or pelvic disease. Many gynecologists and urologists have spoken and written freely on gynecologic and kidney or prostatic low back pain, but I practically never see these patients. If the pain is in the lumbosacral region and this area is tender on deep pressure and if the pain is aggravated by certain movements of the low back or lower extremities, then it originates in the low back. The exceptions are so rare as to be negligible for all practical purposes. Malingering and psychoneurotic backache must be ruled out, but these are not considered as a part of idiopathic low back pain.

If the pain originates in the low back it may be due to a destructive disease of the bone, such as a neoplasm or tuberculosis, to an ankylosing arthritis or to a caudal tumor, to a fracture, or to a spondylolisthesis, and I suspect that in spondylolisthesis the pain is due to the lesion in the disk. All of these conditions, except caudal tumors, can be diagnosed roentgenologically, unless they are examined very early in the disease. As a group, they comprise less than 10 per cent of the cases of low back pain and over half of these are spondylolisthesis and less than a tenth of them are caudal tumors.

This leaves over 90 per cent of the patients with low back pain and over 98 per cent of those with so-called negative roentgenograms in the idiopathic group. It is my opinion that in all of these the lesion is intraspinal in origin

and is due to a lesion of the intervertebral disk. No other pathology has ever been demonstrated as the cause of the pain. It is understood that hypertrophic arthritis, a thickened ligamentum flavum, congenital anomalies of the spine and so-called unstable lumbosacral joints and the other conditions mentioned above are rejected as causes of low back pain. The diagnosis is made from the history and physical examination and no lumbar puncture or spinogram is necessary or even advisable. Roentgenograms may offer confirmatory evidence in that if the lesion is chronic or recurrent the involved disk may be narrowed and the adjacent bone may be eburnated and its margins may be hypertrophied. This ridging of the posterior margin of the vertebral body is considered a part of the disk lesion.

This does not mean that all of these patients should be operated upon and the offending disk or disks removed. As a matter of fact, in only about 10 per cent of these patients is an operation the treatment of choice. In the great majority of them the symptoms either subside spontaneously or yield to conservative treatment and in the remainder the pain and disability are not sufficient to warrant the operation.

It may be argued that in many of these patients no rupture or obvious protrusion of the disk is found at the operation. This does not prove that the disks were normal and Dandy's⁴ concealed disk is a very real and important contribution to this phase of the problem. I, with many others, have been too slow in accepting it. Its recognition permits the surgeon to operate with more assurance that the cause of the patient's pain will be found and relieved.

It is also argued that some patients continue to have pain after the operation. This, too, is true and can be explained by (1) incomplete removal of the offending disk; (2) removal of the wrong disk or of only one disk when two or more are causing symptoms; (3) recurrence or protrusion of more disk material from the operated disk; (4) later protrusion of a neighboring disk; (5) the presence of a ridge of bone at the margin of the offending disk; (6) adhesions following the operation; (7) arachnoiditis or nerve damage from pressure by the disk; and (8) a tumor may have been missed. Many of these unrelieved cases should be operated upon a second time and at this operation a hemilaminectomy should be performed if necessary, and the lower lumbar canal explored thoroughly in an effort to find and remove the cause of the pain. In my experience a spinal fusion has not relieved the pain in patients who have persistent pain and disability after an unsuccessful disk operation and I have now abandoned this procedure as a cure for idiopathic low back pain.

The spinal nerve roots lie close to the anterior wall of the canal and are not subject to pressure by a thickened ligamentum flavum or the lamina. It is thus difficult to explain the relief sometimes obtained by the so-called decompression operations. The relief may be due to the careful freeing up of the nerve roots rather than to the decompression.

The diagnosis of idiopathic low back pain is no longer a problem, because

INTERVERTEBRAL DISK LESIONS

the term is synonymous with a lesion of an intervertebral disk in the affected area. And the same is true of most of those vague unexplained pains in the cervical and dorsal regions in which no pathology or only hypertrophic changes in the vertebrae can be demonstrated. As stated above, hypertrophic changes in the vertebrae are not the cause of pain unless we include the ridging of the vertebral margins beneath the nerve roots which sometimes occurs in old chronic disk lesions, and I consider this part of the disk lesion. It is not the same as the marginal lipping which is so commonly seen in the roentgenogram and does not occur unless the disk is damaged. There will, of course, be an occasional rare exception to this rule.

It is, thus, immediately recognized that the patient with idiopathic low back pain with or without sciatica has a lesion of an intervertebral disk and the problem is to relieve his symptoms in the simplest and safest manner. If our conservative measures fail we can then resort to surgical removal of the cause of the pain and offer him a reasonable chance of a cure. This point of view must be accompanied by the knowledge that in many of these patients the symptoms subside spontaneously, and the firm conviction that in most of the others they can be relieved by conservative treatment. The fact that they may recur is not an adequate reason for operation unless the recurrences have been so frequent and severe that the patient's comfort and welfare are seriously affected by the condition. The operation is an elective major surgical procedure and should not be undertaken lightly.

CONCLUSION

The conditions which we have called low back strains and classified as idiopathic low back pain are lesions of the intervertebral disks in this area.

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DISCUSSION.—DR. GEORGE E. BENNETT, Baltimore, Md.: You have just heard a keynote address on one of the planks of the platform of low back pain. It is very interesting that Doctor Key has keynoted on the same subject on different occasions. It is also interesting to have him summarize his statements with the fact that a large percentage of cases of low back pain are the result of disk lesions but that only ten per cent require operative interference. This statement we should weigh well. I should like to be here about 20 years from now, as I believe Doctor Key would retract some of the statements he made today, as he did some of the statements he made 20 years ago.

I do not wish to discuss the pros and cons of disk lesions. I have one of the cervical spine. I have had symptoms for 20 years and am still doing pretty well, and no neurosurgeon I know wishes to operate upon it. This is a broad subject and I believe orthopedic

surgeons, by and large, are very grateful for the monumental work done by neurosurgeons in helping us in a certain percentage of backaches which, to us, are headaches.

DR. PAUL B. MAGNUSON, Chicago, Ill.: There are many things in medicine which we cannot explain definitely, nor can we always put our finger on the exact cause of symptoms. However, it does seem that a careful analysis should be made of all possible causes of pain in any given location. I have no doubt that Doctor Key believes what he says at this time, but I think, with Doctor Bennett, that we may hear him retract his statements, or very materially modify them, in a few years from now.

It is surprising to me to hear a man of Doctor Key's knowledge and experience explain the common symptom of low back pain on the basis that it is usually due to rupture of an intervertebral disk. Having known Doctor Key for a good many years, I am sure he knows the anatomy of the lower back, and also the pathology. He is familiar with the tissues that make up the lower back, and the mechanical strains that are inflicted upon them, and he knows the conditions that cause pain in other joints of the body. This being true, how he can glibly ignore the anatomic facts and calmly make the statement that the chief cause of low back pain is ruptured intervertebral disk, is more than I can understand.

A study of the lower back would indicate that the tissues involved in its anatomy are the same as those in other joints, controlled by muscles and supported by ligaments; the main difference being that these tissues are more closely in contact with peripheral nerves and their exits; and that the nerves lie in closer proximity to the supporting structures of the back than is the case in most other locations. The ligaments here are more easily strained because of the tremendous leverage put upon them. It occurs to me that we must use common sense, as well as analytic skill and patience, in making our examination, and consider the patient as a whole and not just a pain in the back.

It would be very easy on a doctor's mentality if he could attribute all pain in the upper right quadrant to gallstones and send the patient to the operating room without further to-do. In my opinion, there is just as much logic in sending a patient to the operating room with a diagnosis of ruptured intervertebral disk, because he has a pain in the low back accompanied by sciatica.

The title of this paper is "Disk Lesions are the Chief Cause of Low Back Pain"—let's make a comparable statement: "All kittens born in an oven are biscuits!"

DR. GUY A. CALDWELL, New Orleans, La.: Doctor Key has presented a highly speculative problem. Apparently, his speculations were prompted by a discovery made while performing a laminectomy for removal of a ruptured intervertebral disk under local anesthesia; he noted that on poking an instrument into the disk and prying it against the ligaments he could produce low back pain similar to that of which the patient complained. This finding, which has been previously commented upon by several neurosurgeons, together with the history that is often obtained in such cases, that intermittent periods of low back pain precede the onset of sciatic pain, constitutes the evidence favoring the hypothesis that ruptured intervertebral disks are the chief cause of back pain. I admit that these facts strongly suggest that pressure of a protruding nodule of cartilage against the intervertebral ligaments is the probable cause of the low back pain which precedes the sciatic pain in proved cases of ruptured disk. However, I cannot believe that *all* back pain is caused by degenerated disks trying to force their way through the intervertebral ligaments; overstretching the same ligaments by postural strain or injury doubtless has the same effect. Arthritic changes in the joints formed by the articular facets have been demonstrated by gross pathologic and histologic examinations of the synovial tissue. It is reasonable that pain could originate from these and be referred to the same location as when the corresponding disk is involved.

If we accept Doctor Key's hypothesis that degeneration of the disk is the chief cause of backache, his method of treating them by incision and curettage still remains open to question. Removal of diseased portions does not necessarily arrest the degenerative process. Complete removal of the disk by curettage is virtually impossible, and even if it could be accomplished we do not know that it would stop back pain or even the protrusion of more disk material against the intervertebral ligament. Until we

INTERVERTEBRAL DISK LESIONS

know the causes of degeneration of the disk, we cannot have a logical treatment for preventing or controlling herniation. Certainly, curettage of the unruptured "hidden" disk appears illogical.

Curettage of the disk for relief of back pain should not be regarded as comparable to removal of a disk nodule which is protruding against and compressing a nerve root. The latter has a rational basis, presents a characteristic syndrome that can usually be proved by roentgenographic examination in an opaque medium and the results in well-selected, proved cases are excellent. These probably comprise the majority of the ten per cent of cases to which Doctor Key has referred.

To me, Doctor Key's speculations have been interesting but have added nothing to our real knowledge of the causes of back pain.

DR. R. L. RHODES, Augusta, Ga.: After the facetious remarks of the previous discussers I rather hesitate to speak, but I feel very strongly upon one point which I offer for your consideration. Down our way we have a man who has done a good deal of work on nutritional problems, as many of you know—Doctor Sydenstricker. Under this stimulus I began the study of these cases from the standpoint of nutrition and have come to the conclusion that many of them do not belong in the realm of surgery but in that of internal medicine—problems of malnutrition and avitaminosis. In many cases a careful history will reveal that they have or have had pains in other nerves of the body, facial, intercostal, *etc.*, in addition to the pain in the back and down the sciatic nerve. Internists are seeing many more cases of neuritis of various nerves than ever before, and lay less stress upon focal infection and more upon malnutrition and avitaminosis as the causative factors.

I have had more than 100 cases, have not operated upon one, or seen occasion to refer one to a neurosurgeon for operation. All are people who have been living upon a high acid-ash diet which not only produces a so-called "acidosis" but is low in some of the vitamins. They have cleared up under a carefully balanced diet chemically, rather to the alkaline-ash side to start with and swinging to a normal balance as improvement occurs, plus large doses of the B-group vitamins, thiamin 50 to 100 mg., nicotinic acid 50 to 100 mg., and riboflavin 5 mg. three times a day, this being reduced as pain and discomfort lessen. A good many of these patients had been advised to have a disk removed and sought other advice before submitting to the operation.

In addition to these, I have had 18 cases who had had disk operations, and who were suffering as much or more than before the operation, several having also one or more other nerves involved. These, also, have cleared up under the measures outlined above, and four of them are now in the armed forces. Therefore, I leave this thought—that chemical imbalance of diet and vitamin deficiencies (avitaminosis) are tremendous factors in the solution of many of these problems.

DR. W. J. MIXTER, Boston, Mass.: It seems that the early work in the intervertebral disk has stirred up a hornets' nest. I cannot go all the way with Doctor Key in his speculations. I feel, when it comes to the question of making a diagnosis of ruptured intervertebral disk, that I must have pretty definite evidence before I will accept the diagnosis. I expect to find a fairly classical syndrome, with sciatica, and I want to have visualization by an opaque material, preferably pantopaque. This is my personal opinion in the matter of making the diagnosis of ruptured intervertebral disk. I have operated upon a considerable number of cases without visualization of a ruptured disk or with negative visualization. Once in a while you will find a definite protrusion; more often you will not. These patients do badly; they come back to haunt you, particularly if you have stirred up a disk that was comparatively normal.

My feeling is that I am only interested in the case that demands surgery, in which I can prove a ruptured disk, and I do not want to make that diagnosis unless I can prove it by a protrusion I can see in the spinal canal following visualization. The other cases I would prefer to leave, temporarily at least, as an unsolved problem.

DR. PHILIP WILSON, New York, N. Y.: I think Doctor Key must have foreseen that the paper he was to present at this meeting would arouse considerable discussion and it may have been with the idea of obtaining some support that he invited me as a guest. Whatever the motive, however, I am grateful to him for the opportunity to be present.

Doctor Key framed the title of his paper as a challenge. So far as he is concerned, he is convinced that the intervertebral disk is the site of the elusive pathologic changes we have been trying to find in order to understand better this great medical problem of low back pain. He challenges the rest of us to show that he is wrong; I do not believe we can show he is wrong any more than he can prove he is right. Of course, he is excluding from this consideration those cases in which pathologic changes of various types can be demonstrated roentgenologically. But when you have substracted these cases there still remains a very large group of cases of low back pain. The military hospitals are full of them—young men partly or completely disabled, whose spinal roentgenograms are completely negative. The one new fact added to our knowledge in the last 12 years is an appreciation of the changes, partly degenerative and partly traumatic, that may take place in the intervertebral disks of the lumbar spine. I think if we start from what we have learned in this respect and enlarge and expand the idea a little we will arrive at a position that is not far behind that of Doctor Key.

I will go along with him this far, but I will not agree if the therapeutic implication is to be drawn that the condition is to be treated by direct surgical attack on the injured disk. As a matter of fact Doctor Key more or less skipped the question of treatment, and perhaps he will elucidate more in his closing remarks. We recognize the group of cases with symptoms and signs of intervertebral disk protrusion and agree that a considerable proportion of these require operative treatment, but the remaining cases without evidence of nerve root irritation—and they outnumber the former group by a ratio of at least 50 to one—are in an entirely different class. Many respond favorably to conservative treatment, rest, support and corrective postural exercises. When they do not respond or when they have had so much pain and disability as to require relief from surgery, spinal fusion is the procedure of choice. Immobilization of the damaged joints by an induced bony ankylosis will give complete relief. Most results from these operations have been successful. When pain continues or recurs, a careful check will generally show that the cause is a failure to obtain fusion.

DR. FRANK P. STRICKLER, Louisville, Ky.: I want to speak on this subject from the standpoint of the patient. We have had a regular epidemic of nucleus pulposus operations in Louisville, and in many cases with very bad results. I, therefore, want to register a plea for conservative treatment of these low back cases. The brakes have to be put on this surgical operation somewhere. In my opinion, far too much surgery has been undertaken on these cases in my locality, and I am convinced that operation was not indicated in a number of these patients, for I have examined about 150 of these patients who have been operated upon and the results were shockingly bad. In fact, such poor results have been obtained that a number of industrial insurance companies in Louisville have refused to have this operation performed upon their patients. There is nothing difficult about the operation and, in some few cases, it is probably indicated. But what about the patient? His symptoms are not relieved, and as soon as he applies for a job and is examined and the classical scar is exposed, he is up against it; no one wants to take a chance on him or his back. So he still has his symptoms and, in addition, has a very difficult time in finding employment.

Let us use some practical common sense before these patients are operated upon, along with observation and painstaking physical examination. This operation is not to be taken casually by either the surgeon or the patient, from the standpoint of after-results.

MAJOR BARNES WOODHALL, Washington, D. C.: It may be of some interest to the Association to know something about the results of our treatment of cases of ruptured intervertebral disk in the Army. These statistics were gathered through the kindness of Lt. Col. Michael DeBailey of the Surgeon-General's office. During 1943 the diagnosis of ruptured intervertebral disk was made in approximately 2,450 patients. Because of the line of duty status, or for some other reason, approximately three-fourths of these patients were treated conservatively. By the first of August, 1944, a sample analysis of this group showed that 78 per cent had been discharged from the Army, the assumption being that they could not stand the wear and tear of Army life. A sample of the cases operated upon showed that 31 per cent had been discharged from the Army by August 1, 1944. Among officers, between 0 and 15 per cent were discharged following operation for a protruded disk.

INTERVERTEBRAL DISK LESIONS

The disposition of patients in the Army depends to a large extent upon man-power requirements. During this period of time we were trying to send men back to even restricted types of duty. I might add that all the patients operated upon had either the classical neurologic picture of a ruptured disk or the lesion was demonstrated by pantopaque myelography. All ruptured disks were visualized at operation and there were no concealed disks.

DR. JOSEPH E. J. KING, New York, N. Y.: I want to issue a serious warning against making a fad out of this question of herniation of the intervertebral disk. It would be a pity and a catastrophe if the fine work started by Doctor Mixter and Doctor Barr, to whom full credit should be given, should be prostituted. We have had plenty of fads and fancies in connection with low back pain. As all of you may remember, there was a time when, if a patient could be persuaded to lie on the table on his abdomen for a certain period of time, he would get a spinal fusion. This was true especially in certain localities. Fortunately, this kind of teaching has disappeared for we have all seen the bad effects of it.

In recent years, various men seem to assume that practically all low back pain was due to a ruptured disk, and the patient should be operated upon. If this continues there will be many bad results, as has been stated by Doctor Strickler, and people will not be relieved. It goes without saying that in an instance of true herniation of the disk, it should be removed and a good result can be expected in the majority of cases. It is a great pity that men in high position should speak so glibly regarding the association of an herniated disk with any and all forms of low back pain, and I am afraid that when such teaching emanates from high sources, and is disseminated throughout the country, especially down in the smaller communities, many of the younger men will consider the teaching as authentic, and many bad surgical results will follow.

DR. J. ALBERT KEY, St. Louis, Mo. (closing): I shall try not to leave anybody out. In answer to Doctor Bennett's remarks, that paper was published in 1924, and I have not published a word on the back since—because I did not know.

In answer to Doctor Magnuson, all the physiologic, anatomic and functional reasons for low back pain and sciatica have been investigated and not until the disk lesions were discovered did we have something we could put our finger on and take out and examine pathologically—and know that this was the cause of the pain.

In answer to Doctor King, orthopedic surgeons have been interested in the disk problem from the beginning. I have not forgotten Joe Barr, and I am sure Doctor Mixter would be the first to admit that he had a lot to do with the discovery of the disk as a cause of low back pain and sciatica. We know that disks degenerate after operation and before operation, and often without any symptoms whatever. Anyone who examines roentgenograms of the low back knows that he sees many films of patients who have objective evidence of degenerative processes in the disks, who give no history of pain in the back or of sciatica.

I agree with Doctor Caldwell that this paper does not add to our knowledge of low back pain; it contains no new discoveries. It merely correlates and rationally interprets facts that have been known for years, which are still being misinterpreted. Treatment is not included in this paper. I do not think the perpetuation of ignorance is going to help treatment. The fact that we now know the cause of the trouble does not mean that we have to subject our patients to operation if they can be relieved by conservative treatment. But we might as well know what we are trying to treat instead of trying to immobilize the spine with the hope that the pain will subside.

Ever since vitamins became fashionable I have given all my patients vitamin B—so much so that they think I have stock in the company—but it does not cure this lesion. This lesion is not due to polynneuritis nor to nutritional deficiency.

Of course we like to avoid stirring up a normal disk and sometimes it is difficult to decide whether the disk is normal or not. If I decide that a given disk is the cause of pain (this is a concealed disk) I take it out. And the more experience I have with this condition, the more apt I am to find something that is the cause of pain. It is fine for the neurosurgeons to say that they do not operate except for the typical syndrome, but they send the patient back to the orthopedic surgeon for treatment. The orthopedic

surgeon holds the bag—and a relatively small percentage of these patients have the typical disk syndrome, but many of them demand relief.

In answer to Doctor Wilson's saying that the disk problem is not proved, it is not completely solved, but nothing is proved in surgery if this is not proved. As to the results of spinal fusion, I have reoperated upon five of my own fusions this past summer—and one was not fused—but the pain for which the second operation was performed was due to the disk lesion which I did not find at the first operation, and not to the lack of fusion.

In answer to Doctor Strickler concerning the 150 cases now on his hands who have been made worse by the operation following this epidemic in his city, that must have been very poor surgery, poorly conceived and executed. Everybody knows of some case that has become worse following the operation, but the number is very small. Certainly, in less than five per cent—I would say in less than one per cent—are the symptoms worse after the operation. This would mean that his office is now afflicted with all the failures in about 15,000 operated cases. In my hands the operation is satisfactory in about 85 per cent of the cases. This does not mean that they are all completely relieved, but they are glad they had the operation and so am I. In about 15 per cent they are a good deal better, but not enough to return to their former occupation, and some of these have a good deal of pain. Then there is a very occasional patient (about one per cent) who claims that the disability is worse. I have one case I wish I had never seen, and three or four more that I would just as soon have never seen. With most of them I am very happy.

I did not know that 69 per cent of the enlisted men in the Army with disk operations went back to duty. I think that this is remarkable. I did not know that practically all officers went back to duty. I think the Army is going to re-classify a lot of these backs and use them in light work. This is the answer, just as in civil life.

The history is the important thing in deciding whether or not to operate. What can they do? What will they be able to do after the operation? If they cannot be relieved by conservative treatment and are sufficiently disabled, I operate upon them.

EDITORIAL ADDRESS

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